

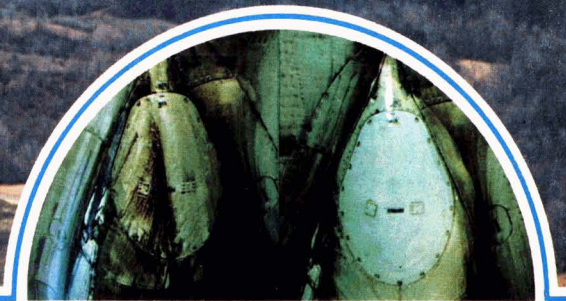
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**JOURNAL OF
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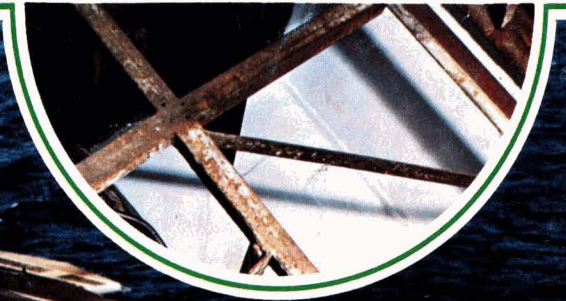
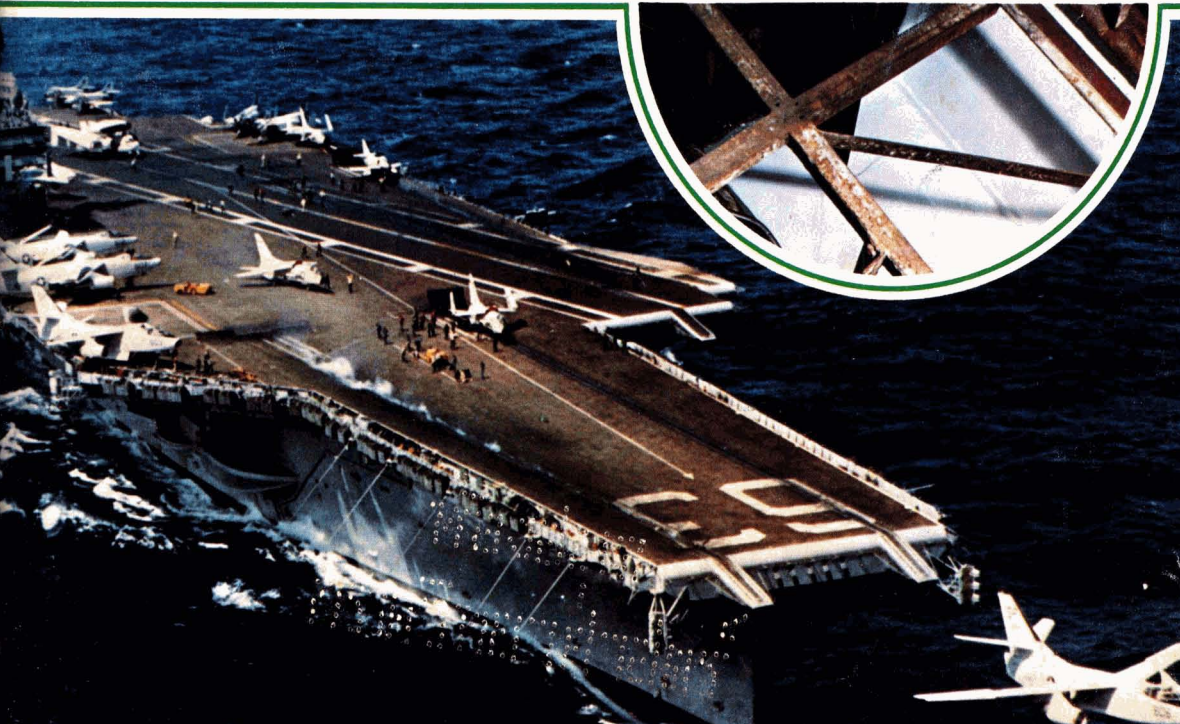
APRIL 1976

Volume 48

Number 615



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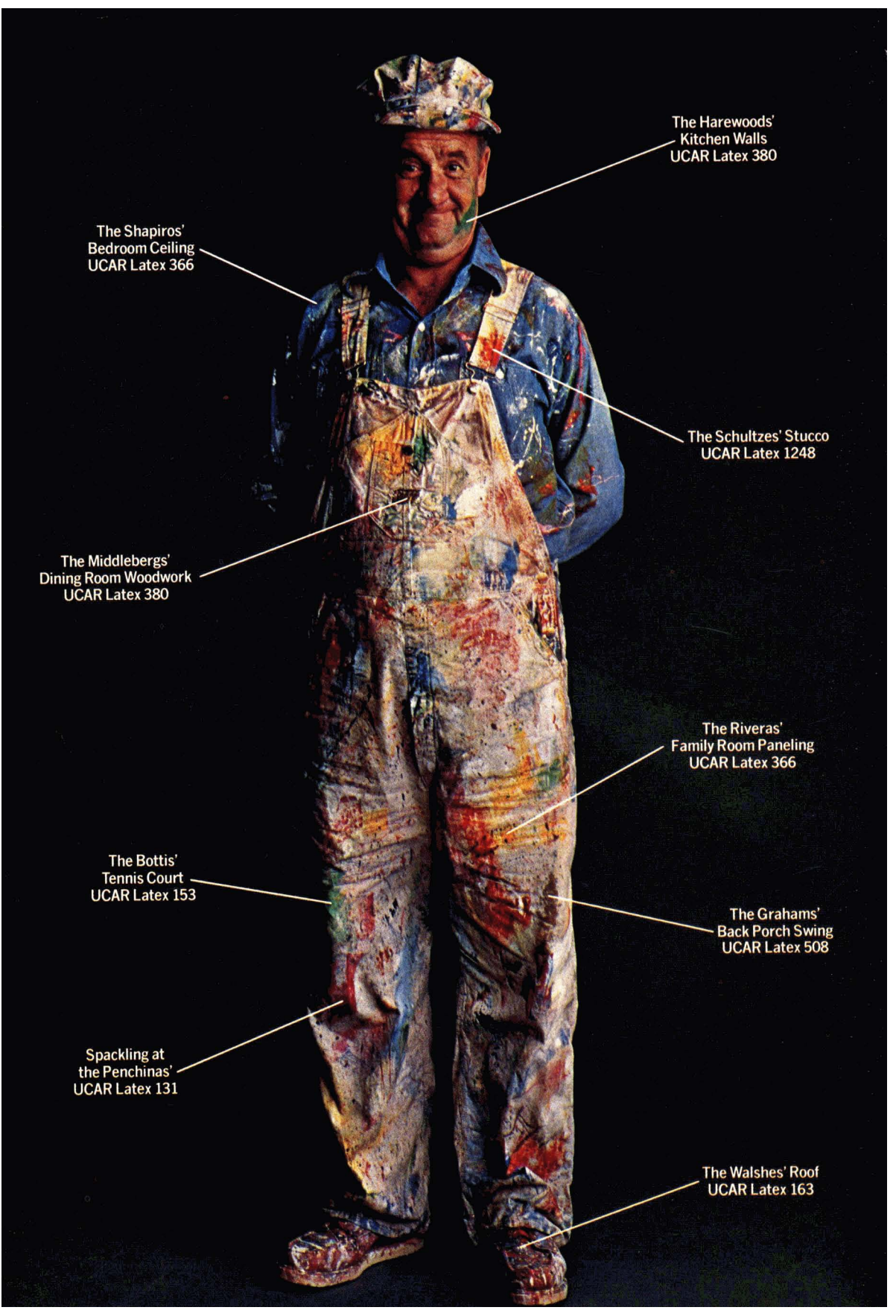
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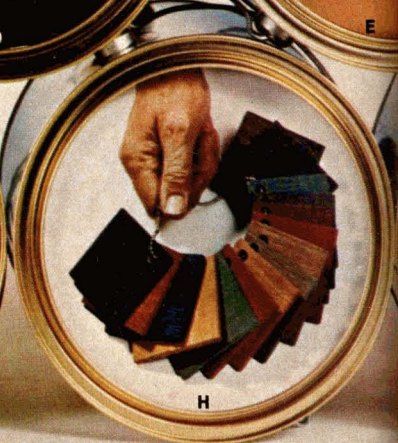
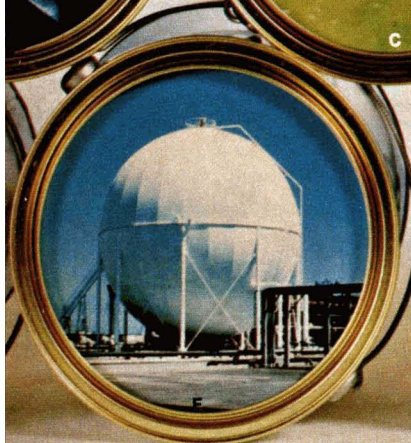
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Volume 48 Number 615

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JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology at 1101 Knox Ave., Easton, Pa. 19042. Editorial and executive offices are located at 1315 Walnut St., Philadelphia, Pa. 19107. Phone: (215) 381-1007. Second class postage paid at Philadelphia, Pa. and at additional mailing offices. Subscriptions: U.S. and Canada—\$16. 2 years, \$29; 3 years, \$40. Other countries—1 year, \$22; 2 years, \$36; 3 years, \$56.



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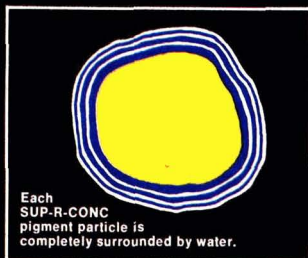
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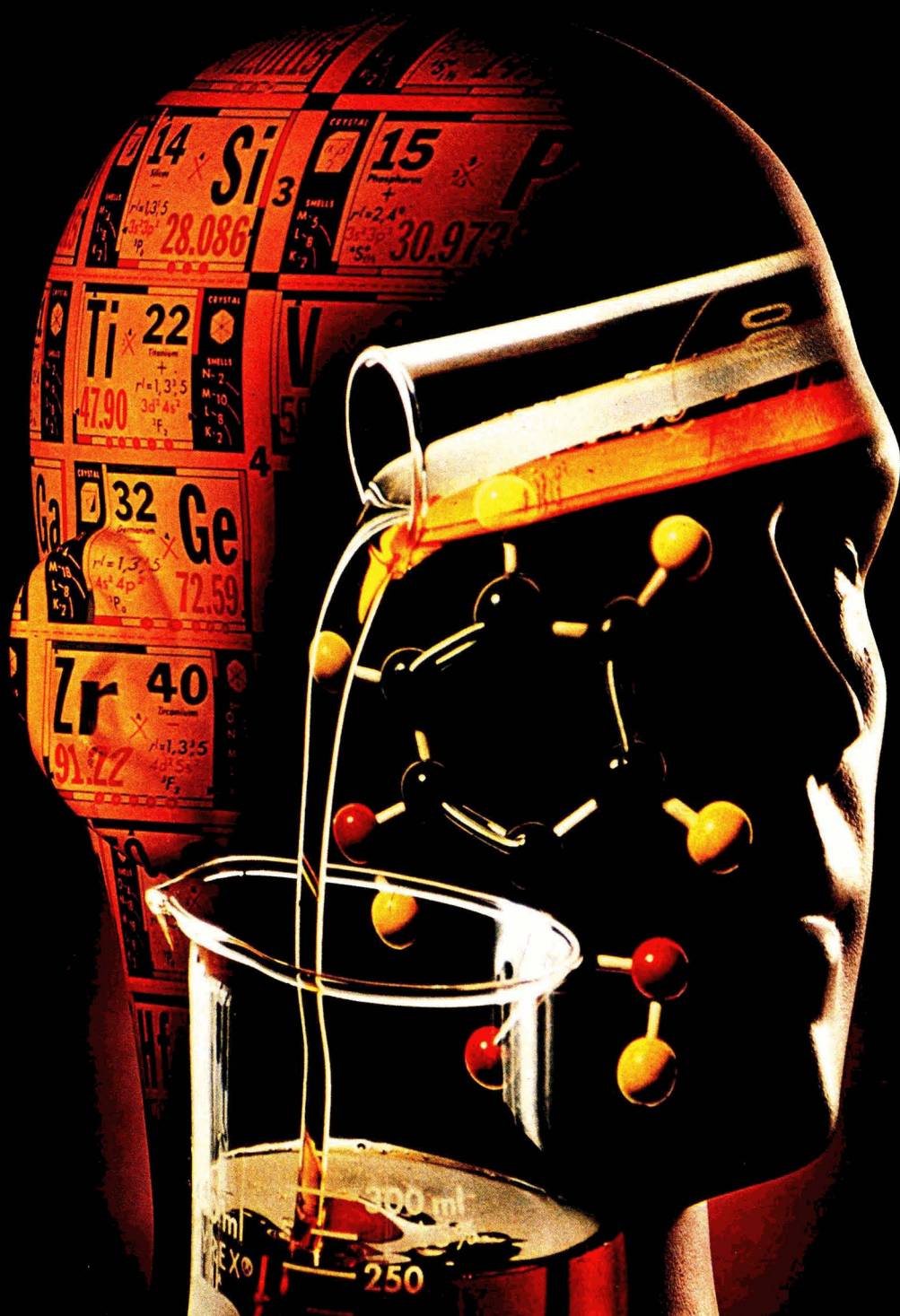
Congress has a penchant for passing laws with little regard for the second order consequences of its legislation. While numerous illustrations may be cited, perhaps the laws concerning automobiles are prime examples. Initial legislation was seemingly innocuous. At the outset there was the mandatory inclusion of seat belts as standard equipment; this led to accompanying buzzers, then to auto-locks unless belts were fastened, and on to other devices that added immensely to auto costs. Of greater impact, however, was the programmed reduction in air pollution via installation of anti-pollution devices. This has doubled gasoline consumption and been a contributing factor to the energy crisis we still face. And exhaust emissions regulations which dictate the use of catalytic converters have been more ridiculous, in that legislation completely ignores the impact of sulfuric acid, one of the key by-products.

Other examples of bureaucratic bungling can be cited with respect to the coatings industry. We have experienced legalistic pressures on solvents, labeling, and on a number of ingredients which go into the manufacture of coatings. The end result of all this is continued price increases, more time and effort of research and development staffs devoted to responding to governmental actions, and less and less to the business of coatings manufacture.


We in this industry must take a positive stand and begin to respond in meaningful ways. We must be aware of pending legislation and urge the congressmen involved to question the consequences. It must, however, be done on a united basis, not only for the coatings industry, but for other industries as well.

Assuredly, there must be a responsible interaction between industry and government, but so far it has all been one-sided. As long as industry permits the bureaucrats to dictate ridiculous laws, our entire economic system will be heading in the direction taken by some of our neighbors overseas.—TJM, Technical Editor

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Abstracts of Papers in This Issue

LABORATORY AND SUCCESSIONAL STUDIES WITH AUREOBASIDIUM PULLULANS—J. A. Schmitt, D. E. Padgett, and J. B. Achmoody

Journal of Coatings Technology, 48, No. 615, 35 (Apr. 1976)

Following a review of laboratory data derived from experiments with our unprotected acrylic emulsion, new data are presented for both laboratory studies and the microbiological succession on test panels exposed at St. Petersburg, Fla., and New Orleans, La. We show that when 0.5% hydroxyethyl cellulose (HEC) is prepared in a mineral salts solution, rather than in distilled water, *Aureobasidium pullulans* grows and reduces the viscosity of the HEC, thereby indicating that it has produced hydroxyethyl cellulase (HECase).

FLUORINATED POLYEPOXY AND POLYURETHANE COATINGS—D. E. Field

Journal of Coatings Technology, 48, No. 615, 43 (Apr. 1976)

A continuing basic research program on the synthesis of fluorinated polymers has provided materials with some unusual properties. Among these properties are superior heat, light, and chemical resistance and low surface energies. In addition, the fluorinated polyol is soluble in common solvents, from which they can be applied to a surface where they can be converted by chemical reactions *in situ* into continuous coatings of a thermoset nature. Such coatings were made from a fluorinated aliphatic and aromatic diol condensed with epichlorohydrin to produce fluorinated polyols. These soluble polyols were then crosslinked with a commercially available polyisocyanate.

REVIEW OF FACTORS DETERMINING SOLUBILITY AND ABSORPTION OF LEAD AND OTHER TRACE METALS IN THE GASTROINTESTINAL TRACT— D. R. Brezinski

Journal of Coatings Technology, 48, No. 615, 48 (Apr. 1976)

The feasibility of establishing laboratory *in vitro* methods of simulating the gastrointestinal processes so as to determine the extractability, solubility and absorption of metals from a paint matrix is investigated. Particular

emphasis is given to lead, its properties and chemistry. An attempt is made to present the many aspects which need to be considered for the purpose of establishing a laboratory method. Hence, a brief description of the digestive system and the physiology of the gastrointestinal tract is outlined and aspects which affect digestion are considered.

NON-MERCURIAL PRESERVATIVES AS SUPPLEMENTS TO MERCURY IN LATEX PAINT— Kansas City Society for Coatings Technology

Journal of Coatings Technology, 48, No. 615, 58 (Apr. 1976)

The previous uncertainty regarding the use of mercurials in coatings prompted this committee to conduct tests using non-mercurial preservatives as supplements to a phenylmercurial in a latex PVA paint.

In order to give the study a frame of reference, results were also obtained using the individual non-mercurials singularly. Thus, some comparisons could be made to the committee's 1973 paper. The same testing procedure was used in both studies.

The accumulated data indicate that some non-mercurials work well in combination with this mercurial with little or no side-effects. Others react negatively, leaving the paint unprotected.

CORROSION INHIBITING PIGMENTS USED IN AQUEOUS COATINGS—New England Society for Coatings Technology

Journal of Coatings Technology, 48, No. 615, 63 (Apr. 1976)

Three different latex vehicles were formulated with five inhibiting pigments and noninhibiting control. Coatings were applied to cold rolled steel panels and evaluated for flash rusting, salt spray resistance and humidity resistance. Results indicate that test methods did not correlate with each other. Flash rusting results were indeterminate indicating an area for possible future work. The vehicle was the most important choice since several types of pigments could achieve equal corrosion resistance.



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Dr. Howard L. Gerhart To Present Mattiello Lecture At Annual Meeting in Washington

The Federation of Societies for Coatings Technology is pleased to announce that Dr. Howard L. Gerhart, Director of the Coatings Research Center at Carnegie-Mellon University, Pittsburgh, Pa., will present the Joseph J. Mattiello Memorial Lecture at the 54th Annual Meeting of the Federation to be held at the Sheraton Park Hotel, Washington, D. C., October 27 - 29.

Dr. Gerhart, who retired in 1974 as Vice-President, Research and Development, Coatings and Resins Div., PPG Industries, Inc., will discuss, "Coatings Engineers and the Companies They Keep — Profitable." He will speak during the Friday afternoon session.

PRI Trustee

A member of the Pittsburgh Society for Coatings Technology, Dr. Gerhart was a Trustee of the Paint Research Institute from 1970-75 and is now an Honorary Trustee of PRI. As Chairman of the Federation's Liaison Committee (since 1973) he is a contact point with affinity technical groups overseas and is well known in the European FATIPEC organization.

Since 1940, he has served on committees for the American Chemical Society and is Editor of *Product R/D*, a quarterly publication of *Industrial and Engineering Chemistry* of ACS. He has been active on committees of the National Paint and Coatings Association and is a recipient of their George Baugh Heckel Award (1972).

Dr. Gerhart's ancestors were farmers who also served as self-educated preachers in the Mennonite Church. In 1927 he entered Franklin and Marshall College to test his aptitude for a theological career. Instead, he graduated with Phi Beta Kappa honors and an assistantship in Chemistry at Northwestern University. Following defense of his Ph.D. thesis, which identified the discovery of a new synthesis of dibutyl magnesium, he began a career of industrial research with PPG Industries, Inc. in 1937.

Inventions

During three years as a bench chemist he made three inventions with commercial impact. The first (U.S. Patent 2,398,889) covered a

Lewis acid catalytic reaction of cyclopentadiene with unsaturated glyceride oils. Before pilot scale-up was completed, he discovered the second noncatalytic synthesis of resin vehicles (U.S. Patent 2,392,140) by a pressure process using cyclopentadiene dimer and trimer. These resulted from designed basic research concepts targeted to ameliorate the non-availability of imported tung oil in 1939. The process was also licensed to oil companies. At the midpoint of the patented period, annual production exceeded 300 tank cars. The specific technology was never published for, says Dr. Gerhart, "There was no time or reason to stop and write papers in that critical period."

A third invention (U.S. Patent 2,424,814) in 1939 departed from coatings science. He credits his early interest in polymer synthesis to Professor Charles D. Hurd who "in a course on the subject, assigned to me the reading of Hermann Straudinger's publication in the original German." The new area was so exciting and convincing that in the first month at PPG he prepared an unpopular memorandum stating that research on the modification of oils with East India gums should be reduced; that the talents of chemists be stretched to supplant the nineteenth century old "Oil-N-Gum" vehicles with polymers of controlled structure and properties.

His attempt to esterify styrene — maleic acid copolymers failed to yield useful paints but succeeded in a new direction. He tamed the exotherm by a study of free radical catalysis in the presence of plasticizers and created a shelf filled with plastic castings from which were machined golf club heads and golf balls. These attracted the attention of "busy" corporate executives who authorized research on (now named) unsaturated polyester resins — an early major diversification for PPG into plastic reinforcement.

Named Director of Research

In 1943 military needs necessitated a reduction in basic programs but offered opportunity for a new experience. Dr. Gerhart, at a young age, found himself supervising a growing staff charged with product development and technical service, plus support to production, selling and man-



agement functions—all accelerated by the needs of 1940-45. He says, "I have been thankful for this experience which taught me the rigors of the frustrations which beset the majority of Federation members in striving to make good products better in concert with other corporate functions."

Following World War II he was named Director of Research. The next challenge was to prove to top management the justification for a new research center. With this, the concentration on signal-getting from fundamental studies was intensified. Dr. Gerhart now launched a 20-year career as teacher and coach. The guidelines included hiring staff from the top of the classes at good universities.

Deprived of the opportunity to personally supervise research experimentation, he substituted a regimen of lecturing and writing on polymer technology and research management. The edited contributions of his staff to annual reviews of polymer coatings became published analytical assessments of current advances. This led to an attempt at career training in which each professional was asked to write periodic reviews, worldwide, on proprietary selected subjects. In recent years he has frequently presented keynote talks, spiced with low-key humor and subtle analogies, to both sci-

Annual Meeting Highlights

entific and management organizations.

Some of his more familiar lectures include: "Signals of Science;" "Domination Index;" "Basic Research Can Be Useful;" "Return on Research Investment;" and the 1973 Annual Meeting Keynote Address, "Making Coatings Science Useful." (See June 1974 JPT, pp. 38-45 — Ed.) Beginning in 1960 he structured an 8:00 a.m. study series (Sunrise Seminar) for recent staff additions. This pioneered (via colleagues) into one of the first formalized industrial training programs in creative problem solving, research management by objectives, and personal development as a key to research for profitability in a competitive climate. His currently favored topic is structured to the thesis that basic research at industrial research centers can be profitable.

Joins Carnegie-Mellon

After retirement Dr. Gerhart joined the Chemical Engineering faculty at Carnegie-Mellon University where he is Director of the Coatings Research Center. He recalls "Professor Vladimir Ipatieff in 1931 at age 65 lectured and started a center for catalytic hydrocarbon conversions at Northwestern. I do not pretend to the same excellence, but I am happy to have the opportunity, in a delightful setting, to stand on a bridge spanning the theoretical with the useful."

Dr. Gerhart's retirement was preceded a few months by the dedication of a second PPG Research Center in a campus setting at Allison Park, Pa. On that occasion he wrote, "This building is a monument to the work of persons devoted to make good products better; to the application of creative talents to excel in the complex competitive arena and to participate in undergirding the corporate prosperity." The subject of the Mattiello lecture, "Coatings Engineers and the Companies They Keep — Profitable," distills career experiences into bite-size portions. He warns, "The paper is long but the talk will be short, conforming to the admonitions of my preacher great-grandfather that 'a soul can be influenced in a few minutes if at all — and sometimes never.'"

Program

The 54th Annual Meeting Program will open Wednesday, October 27, at the Sheraton Park Hotel, Washington, D. C.

Program Chairman Harry Poth has announced the following presentations:

- Mattiello Lecture by Dr. Howard L. Gerhart
- Keynote Address
- Society papers
- Roon Awards papers
- Paint Research Institute Seminar on Mildew Induced Defacement of Coatings
- Manufacturing and Educational seminars
- Overseas papers
- Panel discussions and workshops

Paint Show

Running concurrently with the Annual Meeting at the Sheraton Park will be the 41st Annual Paint Industries' Show, the only national exhibit of materials and equipment used in the formulation and production of paints and related coatings.

Show hours will be: 1 to 6 on Wednesday, October 27; 10 to 5 on Thursday, October 28; and 10 to 5 on Friday, October 29.

To date, 106 companies have contracted for 232 exhibit spaces in the Show.

Headquarters Hotel

The Sheraton Park will be headquarters hotel, with the Shoreham Americana serving as co-headquarters. Rooms have also been set aside at the Washington Hilton and the du Pont Plaza.

Room Reservations

All requests for rooms and suites must be made on the official form which has been mailed to all members. Additional copies are available from the Federation office.

Registration Fees

The regular "on-site" registration fees will be \$35.00 for members and \$50.00 for non-members. Advance registration will be available for \$30.00 for members and \$45.00 for non-members. The fee for Ladies'

Activities will be \$20.00 on-site and \$15.00 in advance.

Once again, there will be a special \$10.00 advance registration fee for retired members.

Registration forms will be included in future issues of the JCT, and will also be mailed to all members of the Federation in August.

NPCA Meets Same Week

The National Paint and Coatings Association will hold its Annual Meeting on October 25-27 at the Washington Hilton.

Program Committee

In addition to Mr. Poth, the following members are serving on the Program Committee:

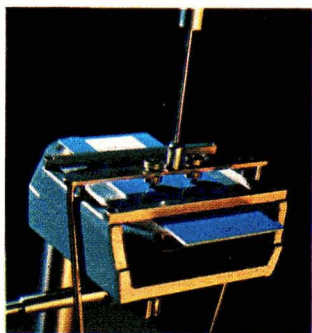
Vice-Chairman — Elder C. Larson, of Shell Development Co., Houston, Tex.; Richard R. Blizzard, of the Levey Div., Cities Service Corp., Cincinnati, Ohio; Richard G. Fortener, of Celanese Coatings Co., Jefferson-town, Ky.; Howard L. Gerhart, of Carnegie-Mellon University, Pittsburgh, Pa.; Paul R. Guevin, Jr., of Hughson Chemicals, Erie, Pa.; Helene R. Johnson, of Lenmar Lacquers, Inc., Baltimore; Ruth Johnston-Feller, Consultant, Pittsburgh; Gabe Malkin, of Benjamin Moore & Co., Newark, N. J.; William Mirick, of Battelle Memorial Institute, Columbus, Ohio; Gene LeVeae, of Pratt & Lambert, Inc., Buffalo, N. Y.; Harry Scott, of Glidden-Durkee Div., SCM Corp., Strongsville, Ohio; Helen Skowronska, of Sherwin-Williams Co., Cleveland, Ohio; and Roy W. Tess, of Shell Chemical Co., Houston.

Meetings Committee

Members of the Baltimore Society for Coatings Technology will serve as Chairmen of the various subcommittees of the Meetings (Host) Committee under General Chairman James McCormick, of Leidy Chemicals Corp., Baltimore, Md. They are: Program Operations — Gordon Allison, of McCormick Paint Works Co., Rockville, Md.; Information Services — William (Tom) Cochran, of Bruning Paint Co., Baltimore; Entertainment — Colin Penny, of Hampton Paint Mfg. Co., Hampton, Va.

Mrs. James (Elaine) McCormick is in charge of the Ladies' Program.

High grade coatings with excellent properties - **VEBA epoxy curing agents**



VEBA-CHEMIE AG supplies for hot and cold curing diamines and anhydrides.

VEBA Diamines

IPD and **TMD** as well as the hardeners **V 214** and **V 215** are clear rather than colorless, low viscosity liquids. They are of aliphatic or cycloaliphatic structure.

VEBA Anhydrides

HHPA, THPA, MTHPA, PMDA are solid, pure white products, **MHHPA** is of low viscosity and liquid.

VEBA Special Hardeners

B 31, B 55 enable manufacture of highly reactive and matt powder coating systems. Try how the VEBA

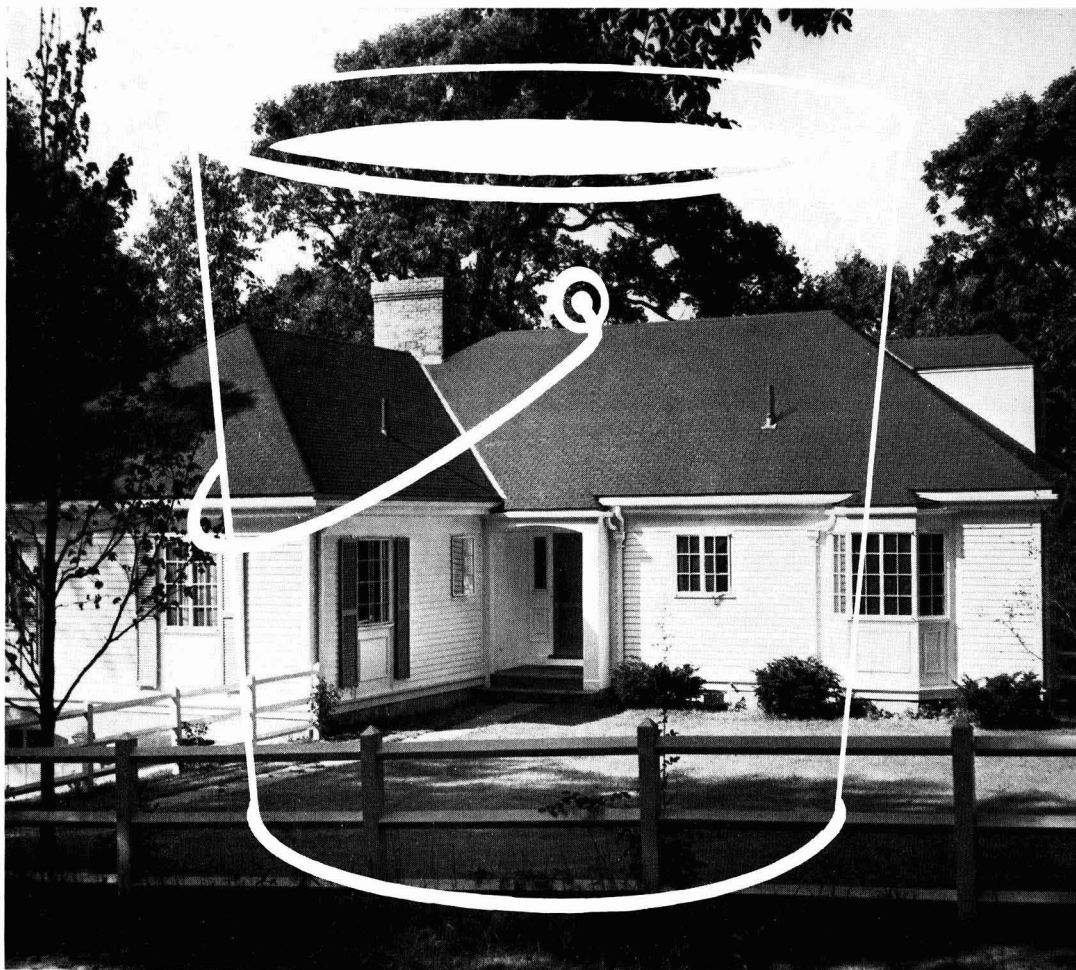
epoxy curing agents can improve your products. If you wish we will give you additional information, free samples and technical advice.

- HHPA = Hexahydrophthalic anhydride
- THPA = Tetrahydrophthalic anhydride
- MTHPA = Methyl tetrahydrophthalic anhydride
- PMDA = Pyromellitic dianhydride
- MHHPA = Methyl hexahydrophthalic anhydride

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Department Ep 103, D 466 Gelsenkirchen-Buer. Our representative in U.S.A.: Thorson Chemical Corporation, Department Ep 103, 299 Park Avenue, New York, N. Y. 10017, Telephone (212) 421-0800, Telex 233 276 RCA, 424 151 ITT

Asarco zinc oxide. A single additive. A bucketful of benefits.



Sure, zinc oxide is number one for mildew control. But that's only the beginning. Today's customers demand more of your paints. They have to last longer, go on easier, and keep their good looks in all kinds of weather.

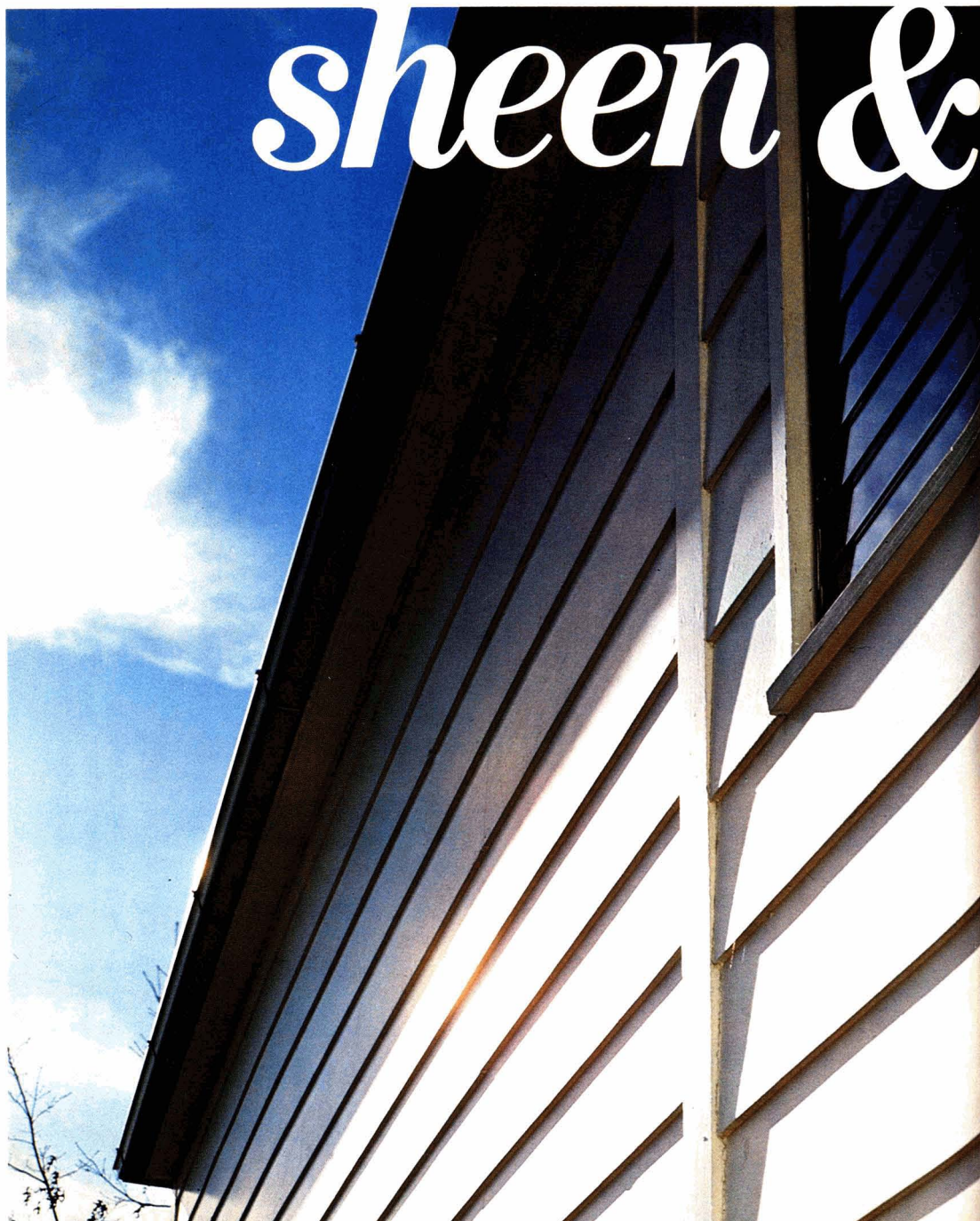
Prepare your paints for the rough life with low-lead Asarco zinc oxides. Your colors will stay true and films will be strong against ultraviolet rays, yellowing, staining and dirt.

Asarco zinc oxides come in large, medium or fine particles. Round or acicular. For latex and oil-base formulas. For more facts write ASARCO Incorporated, P.O. Box 327, Columbus, Ohio 43216.

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**Long-lasting,
clean, just-painted look . . .
indoors and out**

Luster without glare . . . the newest trend in paints . . . eggshell interior enamels and low-sheen exterior housepaints. Painted surfaces radiate a bright clean look for years. The following Rhoplex acrylic emulsions make these paints possible:

Rhoplex AC-388—Smooth flow and leveling. High film build. Excellent outdoor durability—tint retention, chalk resistance, grain-crack resistance on bare wood, adhesion under wet conditions. Makes outdoor and indoor paints.

Rhoplex AC-64—Performance similar to that of Rhoplex AC-388. Exceptional adhesion to exterior chalky surfaces.

Rhoplex AC-25—Superlative flow and leveling. High film build for excellent hiding. Long open time. Exceptional washability without losing gloss or adhesion. Superb for interior eggshell enamels.

Rhoplex AC-490—Outstanding gloss. Proven performance in long history of wide commercial use.

All four vehicles offer attractive multi-purpose capabilities. Use one vehicle for a line of paints. Save through bulk purchases and lower storage costs. Write for emulsion samples and technical literature.

Exterior of house on left was painted in September 1972. Sheen paint made with Rhoplex AC-388 was applied over previously painted hardboard siding.

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Rohm and Haas Company
Independence Mall West
Philadelphia, Pa. 19105

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Indusmin resources brought you Minex, a proven extender for the paint industry... resources that include technical capability, production capacity and precision quality control.

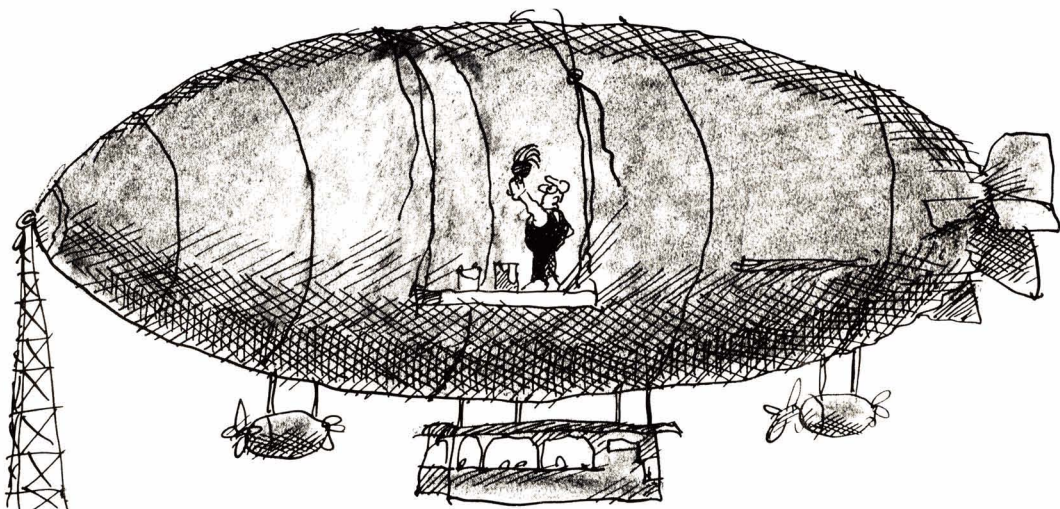
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That's why hundreds of formulators reach for the Cab-O-Sil sample jar, again and again. Our fumed silica is a continuing source of innovative ideas for brand-new products – or for giving *old* products brand-new competitive features.

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One of our nine grades of Amorphous Silica, including three grades of IMSIL® which is the ultimate in Micronized Amorphous Silica, can accomplish about 99% of all filler/extender jobs. And, do it better for less cost. Inert Amorphous Silica is the ideal filler/extender for almost everything. You may think your product is one of the 1% that cannot use Amorphous Silica profitably. Don't make up your mind until you have experimented with our samples.

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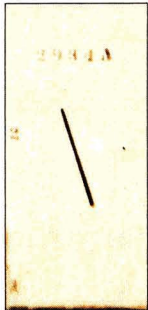
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Tests prove it...

NALZIN™ SC-1... The non-lead that equals or better

40 PVC OIL ALKYD 1:1 PRIMER



NALZIN™ SC-1



Calcium boro-silicate

2 YRS. ATMOSPHERIC EXPOSURE (45° South, Hightstown, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (0.85 lbs./gal.)
Substrate: Hot rolled steel, sandblasted
Application: Brush
No. of Coats: 1 coat primer overall
2nd coat over upper half
Total Film Thickness:
Upper half—3.0 mils (dry)
Lower half—1.5 mils (dry)



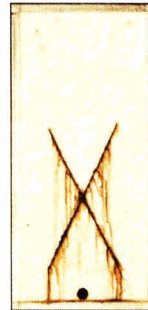
NALZIN™ SC-1



Calcium boro-silicate

2 YEARS MARINE EXPOSURE (45° South, Ocean City, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (0.85 lbs./gal.)
Substrate:
Hot rolled steel, sandblasted
Application: Brush
No. of Coats: 2 self-primed
Total Film Thickness: 4 mils (dry)



NALZIN™ SC-1

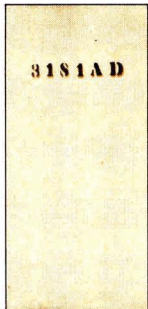


Calcium boro-silicate

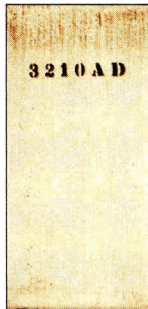
340 HOURS SALT FOG (ASTM Test B117-64)

Corrosion-Inhibitive Pigments:
Equal cost (formulated to constant PVC)
Substrate: Phosphated steel
Application: Brush
No. of Coats: 1
Total Film Thickness: 2 mils (dry)

30 PVC STYRENE ACRYLIC LATEX PRIMER



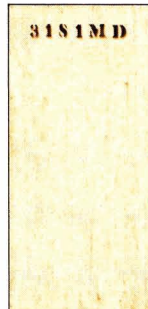
NALZIN™ SC-1



Zinc-calcium molybdate

9 MOS. ATMOSPHERIC EXPOSURE (45° South, Hightstown, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (1.0 lbs./gal.)
Substrate:
Hot rolled steel, sandblasted
Application: Brush
No. of Coats: 2 self-primed
Total Film Thickness: 3.0 mils (dry)



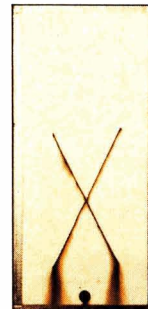
NALZIN™ SC-1



Zinc-calcium molybdate

44 DAYS MARINE EXPOSURE (45° South, Ocean City, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (1.0 lbs./gal.)
Substrate:
Hot rolled steel, sandblasted
Application: Brush
No. of Coats: 2 self-primed
Total Film Thickness: 3.0 mils (dry)



NALZIN™ SC-1



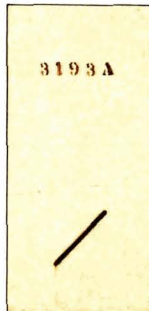
Zinc-calcium molybdate

350 HOURS SALT FOG (ASTM Test B117-64)

Corrosion-Inhibitive Pigments:
Equal cost (formulated to constant PVC)
Substrate: Phosphated steel
Application: Brush
No. of Coats: 2
Total Film Thickness: 2 mils (dry)

corrosion-inhibitive pigment anything you are now using.

30 PVC ACRYLIC LATEX PRIMER



NALZIN™ SC-1



**Zinc-calcium
molybdate**

9 MOS. ATMOSPHERIC EXPOSURE (45° South, Hightstown, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (1.0 lbs./gal.)

Substrate:

Hot rolled steel, sandblasted

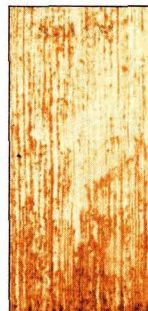
Application: Brush

No. of Coats: 2 self-primed

Total Film Thickness: 3.0 mils (dry)



NALZIN™ SC-1



**Zinc-calcium
molybdate**

44 DAYS MARINE EXPOSURE (45° South, Ocean City, N.J.)

Corrosion-Inhibitive Pigments:
Equal weight (1.0 lbs./gal.)

Substrate:

Ho. rolled steel, sandblasted

Application: Brush

No. of Coats: 2 self-primed

Total Film Thickness: 3.0 mils (dry)

NALZIN™ SC-1 is a remarkably versatile, lead-free corrosion inhibiting pigment. A zinc phospho oxide complex, it works equally well in both aqueous and solvent-based coating systems—oil/alkyds, acrylic latexes, styrene acrylic latexes.

The exposure tests shown here speak for themselves. What they show and what you can count on is:

- NALZIN SC-1 Pigment performs as well or better than standards of the industry at all levels tested.
- It exhibits mildew resistance lacking in other anti-corrosive pigments.
- It consistently equals or tops competitive pigments both at equal weight and at equal cost levels.
- Low levels perform as well as high loadings, so it takes less to achieve good results.

In addition to its demonstrated advantages, NALZIN SC-1 Pigment has proved to have other highly desirable cost and performance features:

- Stable in a wide variety of binder systems.
- White color and low tinting strength allow formulation of virtually any color coating.
- Minimizes tendency for flash rusting in aqueous coatings.
- Excellent throwing power and can stability in electrodeposition systems.

NALZIN SC-1 Pigment may well be the best answer yet to reformulating corrosion-inhibiting coatings to meet today's needs. For further information and any help you may need in formulations, contact:

Industrial Chemicals Division, NL Industries, Inc., Box 700, Hightstown, N.J. 08520. Telephone: (609) 448-3200.

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N Industrial
Chemicals

News from Washington

EPA Grants Stay of Mercury Ban

In response to motions filed by the National Paint and Coatings Association and the principal suppliers of mercurial pesticides to the paint industry, the Environmental Protection Agency, on March 2nd, granted a temporary stay of the Administrator's Order of February 17, 1976, which had prohibited further production of mercurial pesticides (see March JCT, pages 18 and 19).

The stay applies to all registrations which were cancelled under the February 17 order.

The stay specifically provides that the average monthly amount of mercurial pesticides produced and formulated during the period the stay is in effect (through June 30, or the conclusion of judicial review proceedings, whichever comes first) may not exceed the average monthly amounts produced and formulated during the year immediately preceding the February 17 Order. The decision further provides that the stay may be immediately dissolved if the EPA learns that any of the parties who manufacture or formulate mercurial pesticide products whose reg-

istrations were cancelled by the February 17 Order has increased production and/or is stockpiling quantities of mercurial pesticides.

If judicial review is not completed by June 30, petitions may be filed at that time for an extension of the stay.

The February 17 Order by EPA Administrator Russell Train overturned a finding made December 12, 1975 by EPA Administrative Law Judge Bernard Levinson that the paint and coatings industry should be allowed to continue using phenylmercuric compounds in latex paint and coatings products. NPCA subsequently challenged the February 17 Order and joined with major suppliers of mercurial pesticides to the paint industry (Cosan Chemical Corp., Tenneco Chemicals Inc., and Troy Chemical Corp.) in seeking relief from its effect. A Petition for Review was filed with the U. S. Court of Appeals for the Third Circuit on February 19.

The Association joined the other interested parties in requesting a

stay from EPA, pending judicial review, of the effective date of the prohibition on the production, formulation, sale and use of the mercurial products whose registrations were cancelled by the February 17 Order. The temporary stay is the result of that effort.

Hazardous Chemicals Labeling Standard Approved by ANSI

The American National Standards Institute has approved a new standard for the labeling of hazardous industrial chemicals.

Numbered Z129.1, the standard was prepared by the Manufacturing Chemists Association Labels and Precautionary Information Committee. It was adopted by ANSI after balloting of concerned organizations, in accord with the Institute's rigorous consensus review procedures, to insure insofar as possible that the standard is in complete accord with the public interest.

Copies of Standard Z129.1 may be ordered from Sales Department, American National Standards Institute, 1430 Broadway, New York, N. Y. 10018.

Initial 1976 Contributions Received for PRI

Funds in support of the research efforts of the Paint Research Institute's 1976 programs have been received from the following: Cleveland Society for Coatings Technology, Detroit Society for Coatings Technology, New England Society for Coatings Technology, Southern Society for Coatings Technology, Baltimore Coatings Association, Detroit Paint and Coatings Association, Canada Colors and Chemicals Limited, Gulf Oil Canada Limited, and Shell Chemical Co.

The contributions are the first received this year for the Federation's research affiliate, and will supplement the funds committed by the Federation to PRI for this year's projects.

Last year, funds were received from 59 contributors.

Fluorocarbon Data Report Available from MCA

Annual and cumulative production data has been collected by the Manufacturing Chemists Association on FC-11 (trichlorofluoromethane), FC-12 (dichlorodifluoromethane), and FC-22 (chlorodifluoromethane) from the start of commercial production through 1975. In addition, data on sales by major end use categories have also been obtained.

Lack of accurate production and release data on these fluorocarbons has created uncertainties in scientists' earlier calculations of the effect of fluorocarbons released to the atmosphere.

Total world production from the date of first manufacture through 1975 has been: 7,562 million lb of FC-11; 11,197 million lb of FC-12; and 1,670 million lb of FC-22. Production through 1973 was higher than the previous estimates used for modeling calculations by 9.2% for FC-11 and 10% for FC-12. Annual rate of growth between 1967 and 1973 averaged 13.3% for FC-11 and 9.5% for FC-12, compared with previous estimates of 14.4% and 13% per year, respectively. However, production of both compounds in 1974 increased only by about 5% over 1973, and decreased by approximately 15% in 1975 from 1974 figures.

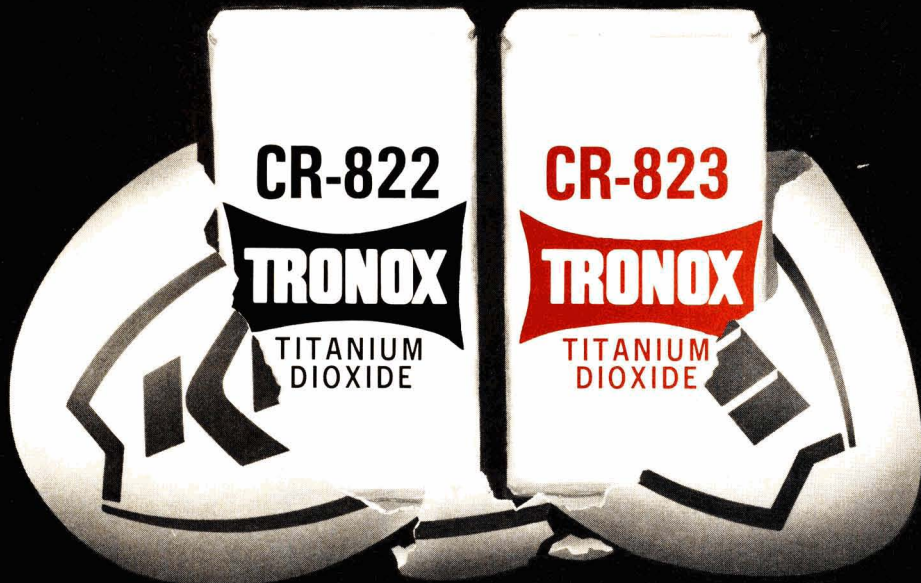
MCA is currently administering a fluorocarbon research program designed to contribute to scientific understanding of the effects, if any, of fluorocarbons on the depletion of ozone. Twenty manufacturers throughout the world, representing more than 95% of total world production, support the research program and supplied the production and sales data to Alexander Grant & Company, an independent accounting firm.

Sales by major use categories for the past 20 years were also supplied in order to permit a calculation of the quantities of the fluorocarbons that have been released to the atmosphere.

Production data were obtained from several other small producers and the production of all the remaining producers in the world was estimated by companies supporting the research program. All production data exclude those fluorocarbons used as intermediates in the manufacture of other chemicals or plastics.

Copies of the report are available from MCA. Write Manufacturing Chemists Association, 1825 Connecticut Ave., N. W., Washington, D. C. 20009.

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Two new Tronox titanium dioxides
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- GET** • Higher hiding with good film integrity... therefore lower cost
• Dispersibility

- FOR** • Low gloss and flat coatings
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SILICONES



2,000 companies, located all over the world, have asked for this free kit and are seeing for themselves the advantages of Multiflow™ resin modifier.

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Last year, we told people that our new Multiflow flow aid was bad news for silicones. Not only because it was comparable in price to silicones. But because Multiflow improved flow and reduced pinholes and craters in solvent-based coatings without the contamination and recoat adhesion problems of silicones.

The result: over 2,000 companies had to see for themselves. Which we feel is more bad news for silicones.

These companies are beginning to report back to us on just how superior Multiflow is. They're discovering that Multiflow aids both substrate wetting and air release. Also they report Multiflow maintains and improves initial adhesion.

What's more, by using Multiflow they're discovering they can eliminate the risk of silicone overspray contamination of unpainted surfaces before they reach the coating line.

But how about you? Have you sent for your free Multiflow test kit? You should. Chances are one of your competitors has a kit. And these days, you can't afford to let your competitors get an edge on you.

Monsanto

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- I want to see for myself, too. Send me your free Multiflow test kit.
 My flow and cratering problems are urgent. Have your technical representative call me at:

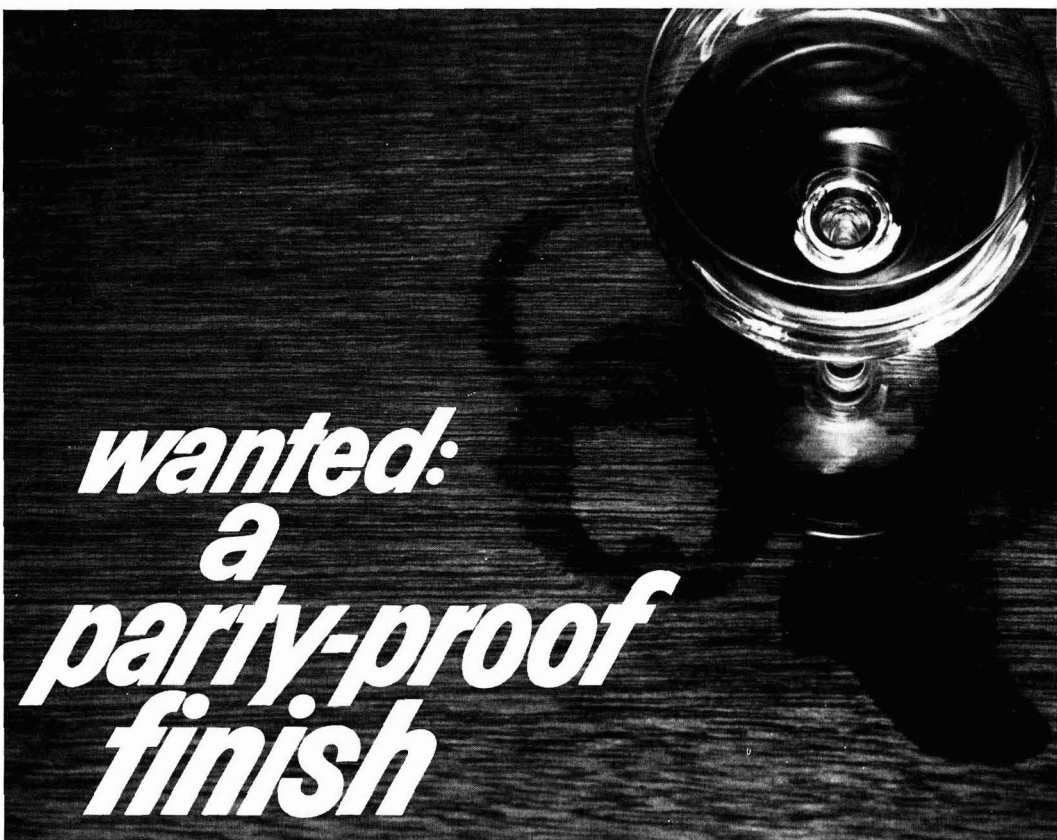


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New NeoCryl A-620 water-borne acrylic polymer increases resistance of wood finishes to alcohol and water at a cost you can afford.

Acrylic coating systems made with Polyvinyl's new NeoCryl A-620 polymer have all the advantages of the air-dry, water-borne NeoCryl A-600 series plus exceptional resistance to alcohol and water. High gloss clear and pigmented systems make A-620 ideal for wood finishes as well as for paper and metal coatings. Not only does A-620 have five times the alcohol resistance and four times the water resistance of other NeoCryl acrylic emulsions, but the polymer contains a higher percentage of solids at 20% less cost per solid pound.

Polyvinyl's A-600 emulsions adhere well to a wide variety of substrates including wood, plastics, metal, paper and cement, as primers and topcoats. A-620 is no exception. They have lacquer-type drying characteristics, dry quickly to a hard, flexible film (as hard as typical solvent solution acrylics) and can be applied by spray, dip-tank, flow coating and roller coating techniques.

For further information and specific data on NeoCryl A-620, contact Polyvinyl Chemical Industries, 730 Main Street, Wilmington, Mass. 01887 or phone direct to (617) 658-6600

Polyvinyl Chemical Industries



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Beatrice Chemical
Division of Beatrice Foods Co.

A toast to better drying performance and cost savings with Zirco[®], first choice of knowledgeable paint formulators. Together with cobalt or manganese, Zirco gives you faster drying action. That's because Zirco is formulated differently from other zirconiums. What's more, since Zirco is much more efficient, you use less and save with drier costs on every gallon of

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Write or call Bill Schneider today to learn how easy it is to switch to the Zirco system.

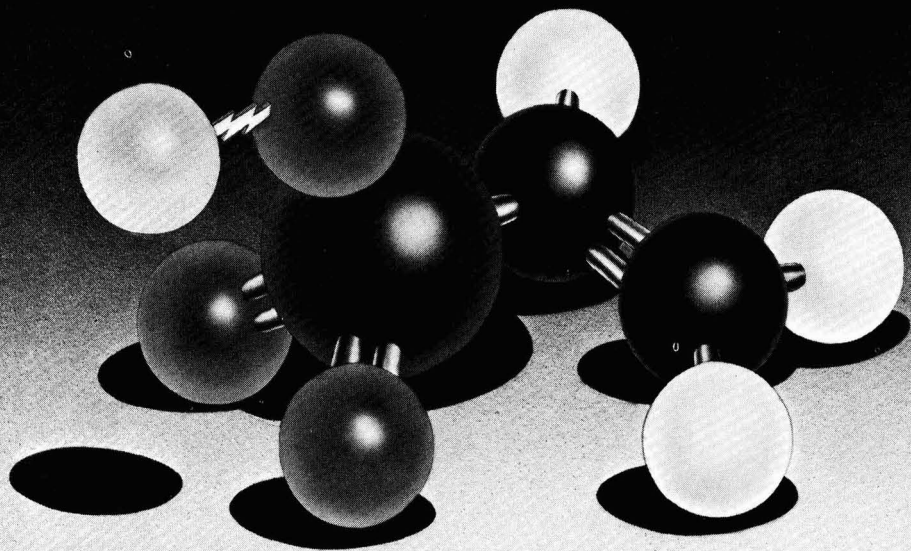
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**The champagne of
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Currently, major latex producers are using it as an emulsion stabilizer in vinyl acetate and acrylic systems. And as an additive to reduce the formation of coagulum and grit during emulsion polymerization.

But there's more to it than that. In the textile industry, you can use it as a comonomer to improve the dye receptivity and anti-static properties of fibers. In water treatment systems, you can use it in the

preparation of ion exchange resins and polymeric flocculants. In metal plating, it can often be an excellent brightening agent.

In short, SVS has many applications in many areas. Find out what it can do in your particular area of interest: we'll work with you to help evaluate likely applications.

For technical information and a free sample, just write to us on your letterhead or use the coupon.

(By the way, the SVS molecular model shown above may not tell the whole story. Chemically, it looks like this: $\text{Na SO}_3 - \text{CH} = \text{CH}_2$.)

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 Literature on sodium vinyl sulfonate

Name

Title

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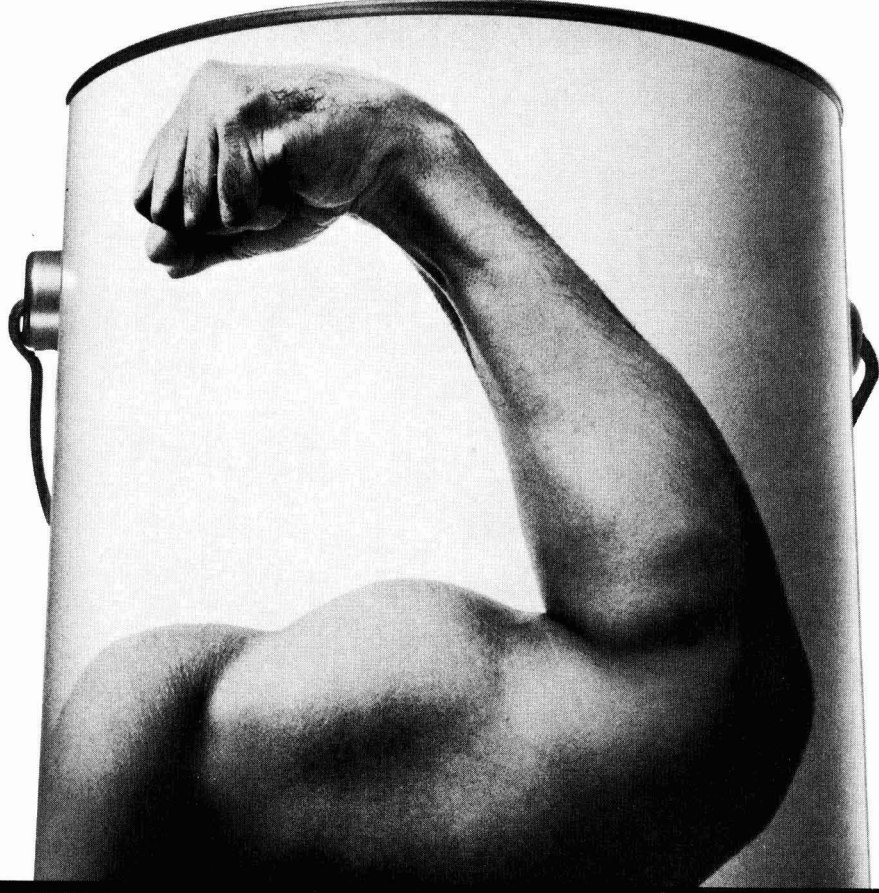
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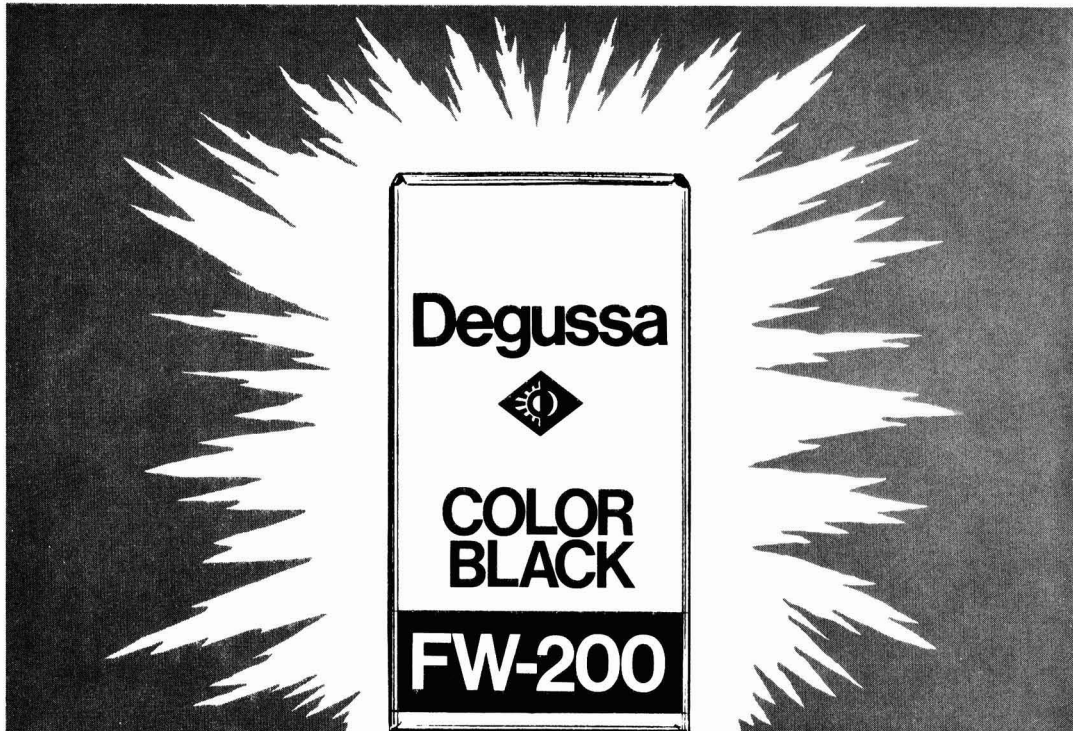
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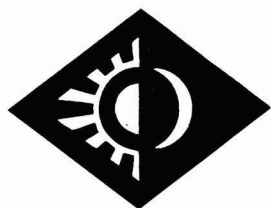
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Laboratory And Successional Studies With *Aureobasidium Pullulans*

J. A. SCHMITT, D. E. PADGETT,* and J. B. ACHMOODY
Ohio State University†

Following a review of laboratory data derived from experiments with our unprotected acrylic emulsion, new data are presented for both laboratory studies and the micro-biological succession on test panels exposed at St. Petersburg, Fla., and New Orleans, La. We show that when 0.5% hydroxyethyl cellulose (HEC) is prepared in a mineral salts solution, rather than in distilled water, *Aureobasidium pullulans* grows and reduces the viscosity of the HEC, thereby indicating that it has produced hydroxyethyl cellulase (HECase). We also present preliminary results of an attempt to ascertain the successional history of both bacteria and fungi on the test panels self-primed with our acrylic emulsion.

KEY WORDS: Microecology; Fungal succession; *Aureobasidium pullulans*; Paint mildew; Hydroxyethylcellulose.

INTRODUCTION

Fungi are an important concern to the coatings industry. There is abundant evidence of the disfigurement of both interior and exterior paints due to the growth of fungi. As indicated by Goll *et al.*,¹ Jakubowski,² and Ross,³ *Aureobasidium pullulans* is incriminated as the fungus of greatest interest and concern. Yet other fungi have been reported from naturally mildewed coatings, which undoubtedly accounts for the inclusion of *Aspergillus niger* and *Penicillium* sp. (ATCC #9849) in the specifications

for the rapid testing of mildewcides, as proposed in the ASTM drafted protocol (personal communication from R. H. Lalk).

All of the previously reported isolations of fungi and bacteria from mildewed surfaces seem to have been obtained from one-time recovery procedures. Allsopp *et al.*⁴ called attention to the paucity of long-term ecological studies into the microbiology of paint mildew. No concern has been shown for investigations of the interrelationships of the several microorganisms among themselves or between them and their microenvironments. Few, if any, attempts have been made to sort out the real film invaders from the airborne microorganisms that have been casually deposited on the sampled site from the ambient air or nearby soil. It is difficult to accept the implication that there are not interactions between and among the microbial flora constituents present on the test film.

It is probable that part of the attention paid to *A. pullulans* is because of its high index of visibility. But what about other, less visible microorganisms and their role(s) in the mildew induced defacement of organic coatings, now identified by the acronym, MIDOC? By whatever recovery techniques used, bacteria also have been more or less invariably recovered from mildewed surfaces, as witnessed by the extensive coverage of the subject in the literature review prepared for the Paint Research Institute (PRI) by Brand and Kemp.⁵ Winters⁶ and Winters *et al.*⁷ have shown unequivocally that bacteria belonging to the genus *Pseudomonas* are able

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* Present address: University of North Carolina, Wilmington, N. C. 28401.

† Department of Botany, Columbus, Ohio 43210.

to bring about the package spoilage of paint, manifested primarily by a loss of viscosity, through the elaboration of cellulase and the enzymatic hydrolysis of hydroxyethyl cellulose (HEC) and other celulosic thickeners. Earlier reports from our laboratory (Schmitt & Padgett;⁸ Schmitt^{9,10}) have indicated that in pure-culture experiments *A. pullulans* is unable to utilize HEC by itself in a paint film or in 0.5% concentration in distilled water (DW); nor was growth sustained using any other ingredient of our experimental paint as sole carbon source. Contrariwise, we have evidence (unpublished data) that *A. pullulans* is able to utilize a polyacrylic thickener in DW, resulting in an increase in fungal biomass and an unquantitated loss in the viscosity of the solution.

There was evidence (Schmitt¹⁰) that *A. pullulans* is able to sustain growth on our acrylic emulsion only when the film has been modified by the prior growth of *Pseudomonas* sp. For example, when a pure-culture inoculum of *A. pullulans* is aseptically transferred onto films of our unmodified emulsion, growth occurs for two to three weeks, at which time dormancy sets in. On *Pseudomonas*-modified films, the fungus grew for at least 10 weeks when the experiment was terminated.

It is often said that one of the reasons *A. Pullulans* becomes offensive only after three to four years following a repainting is a gradual lowering of the pH of the film. Data on the composition of our experimental acrylic paint were presented elsewhere (Schmitt¹⁰), indicating a pH of 9.4-9.7 at formulation. One of our early experiments (unpublished data) looked to the effect of pH on the growth of *A. pullulans*. Culture media consisting of 0.5% paint in nutrient broth was prepared and aliquots buffered over the pH range of 5.5-8.2. Growth (increase in biomass) was monitored by absorbance readings at 715 $m\mu$ in a Spectronic 20 (Bausch and Lomb) colorimeter over an 11-day incubation period. Little or no growth, as inferred from the absorbance data, occurred at pH 8.2, minimal growth occurred at 5.58, with optimal growth at 7.0. Disregarding pH 8.2, optimal growth regardless of pH occurred on the fourth day. These data, of course, are not directly transferrable to a paint film situation, but they may give a valid impression of the pH effects of the growth of *A. pullulans* *in vitro*. Although lowering of the pH of a paint film in time may be a factor contributing to accelerated growth of *A. pullulans*, it is difficult to relate defacement strictly to pH changes.

Before initiating field exposure studies to determine a possible long-term succession of bacteria and fungi that leads ultimately to severe mildewing of our acrylic paint, we wanted to follow-up on Winters' finding (personal communication) that 0.5% HEC in mineral salts solution was degraded by *A. pullulans* in pure culture.

PROCEDURES

In our experiments 0.5% HEC was prepared in a simple 4-salt solution (see footnote to Table 1) suggested by Winters (personal communication), in Czapek's mineral salts solution (see Beneke¹¹: 34), and in *Neurospora* minimal salt solution (see Foster¹²: 231). Triplicate flasks of each 0.5% HEC-salts solution were inoculated with *A. pullulans* and incubated at 25°C; 0.5% HEC in DW served as the control.

Another series of solutions was prepared to include the complete medium of Winters and solutions in which one of the salts was omitted from each solution; HEC was added to the 0.5% level. Flasks of all 5 HEC solutions were inoculated with *A. pullulans* and incubated at 25°C for two weeks. Two sets of controls were included: (1) 0.5% HEC in DW, inoculated with our fungus; and (2) 0.5% HEC in complete salts solution, but uninoculated.

RESULTS

Initially, experiments were carried out using Winters' salt solution, consisting simply of KH_2PO_4 , $MgSO_4$, NH_4Cl , and $FeCl_3$ at the concentrations indicated in the footnote to Table 1. Our results confirmed those of Winters; growth did occur. In an effort to determine the possible influence the complexity of the salt solution might have on the growth of our fungus, first Czapek's salts solution (see Beneke¹¹: 34), then *Neurospora* minimal salt solution (see Foster¹²: 231) were substituted for the Winters' solution. Other procedures were identical to those employed for the earlier experiments. Again, the increase in the amount of the pigmented fungus with time in the several media suggested concurrence in results between these three salt solutions, insofar as they were effective in bringing about the extracellular manifestation of hydroxyethyl cellulase (HECase), while the HEC in DW again failed to indicate HECase induction.

In an effort to ascertain which ion(s) might be responsible for the observed differences between Winters' salts solution and DW in HECase-related phenomena, a series of one-salt deficient media were prepared, inoculated, and incubated as described above. Growth of *A. pullulans* occurred in all inoculated flasks except the HEC in DW; the criterion of growth was an increase in biomass (dry weight of mycelium) of the fungus. By using filtration time as an index of viscosity, there was a loss of viscosity in all flasks where growth was evident, as is indicated in Table 1. Dry weight and viscosity change were determined by timing the vacuum-filtration through Whatman #1 filter paper in a Buchner funnel. Filter papers were tared and dried at 60°C for 24 hr prior to filtration; they were returned to the oven for 48 hr prior to re-weighing. The difference between the second and first weights repre-

Table 1—Effect of Mineral Salts^a 0.5% HEC on Viscosity and Growth of *Aureobasidium Pullulans*

	Visual Decrease in Viscosity:	Time (sec) ^b thru filter (12 hr +)	Mg. Increase ^b Dry Wt.	Comments
Uninoculated				
Inoc. Complete	Y ^c	32	1.7	Growth as small white particles; heavy growth; medium opaque
-KH ₂ PO ₄	Y	57	2.7	Growth as large white particles; some clumps; medium clear
-MgSO ₄	Y	87	3.0	(Same as for complete medium)
-NH ₄ Cl	Y	235	5.0	Growth gray-white medium-sized particles; medium clear
-FeCl ₃	Y	50	1.7	(Same as for complete medium)

(a) in grams per liter, HEC-5.0, KH₂PO₄-1.0; MgSO₄-0.5; NH₄Cl-1.0; FeCl₃-0.8 (use 1 ml FeCl₃ solution/50 ml medium).

(b) Average of 3

(c) Y = yes

sents the mg of mycelium produced on a dry weight basis.

The data in Table 1 lead us to attempt to ascertain the relative importance of the several ions present in the 4-salt-HEC media. Accordingly, solutions were prepared in which KCl was substituted for KH₂PO₄ or MgCl for MgSO₄, etc. Results from these cursory substitution experiments were less definitive than the deficiency experiments. Although more extensive experimentation needs to be completed on this aspect of the nutrition of *A. pullulans*, the results of the mineral nutrition experiments tend to support the inference that sources of nitrogen and of sulfur are important, perhaps principally because of their roles in amino acid and protein synthesis and hence in connection with nucleic acids and their control of organismic functions. It also appears that there is an inverse relationship between increase in biomass of fungus and HECase production, i.e., the greater the increase in dry weight of mycelium, the lesser the amount of enzyme produced. It further appears that *A. pullulans* has no specific growth requirement for Fe+++ as a trace mineral, since the same average increase in dry weight was achieved in the complete medium and the -FeCl₃ medium. Although no experiments were performed specifically with Zn or Cu, there is no evidence that our fungus has a specific requirement for them as trace minerals.

Although the mechanism of the observed salt-induction or -manifation of HECase of *A. pullulans* cannot be explained at this time in precise terms, the concept may have application to the defacement of exterior coatings by the fungus. The data also emphasize the need for a re-evaluation of the reported symbiosis between *A. pullulans* and

pseudomonads espoused earlier (Schmitt^{9,10}). No one can dispute the fact that dust, whether soil particles or organics, adheres to an exterior painted surface. Given the presence of moisture, a mineral salts solution is formed and could possibly be responsible for the extracellular manifestation of HECase produced by *A. pullulans*. Such a situation would obviate the necessity for some other organism, e.g., *Pseudomonas* sp., to initially modify the film before the fungus could become established.

We turned our efforts to attempts to obtain a microbial ecological history of mildewed test panels. Field studies were initiated in early January 1975; they were designed to elucidate not only the different kinds of bacteria and fungi occurring on the surface of panels, but also to determine the sequence in which these microorganisms infested the film. Toward this end, panels self-primed with our acrylic emulsion¹⁰ were placed on north-facing (N-) and south-facing (-S-) fences near St. Petersburg, Fla., on January 3, 1975, and similarly oriented fences south of New Orleans, La., on January 25, 1975. The finish coat of the unprotected paint was applied on site, at the suggestion of Goll (personal communication). The recovery of microorganisms from the panels was initiated immediately after placement on the fences (0 hr) and was continued at 4-hr intervals to 12 hr. Thereafter, sampling was done on Day 2 (approximately 24 hr) and every-other-day for seven samplings, then once a week for six weeks, and finally once a month until termination of the study (complete failure of the film).

Our sampling procedures were as follows: Small (55 mm) petri dishes containing a slightly convex layer of agar were used to sample the surfaces. These special dishes were obtained from the

Table 2—Principal Fungi Recovered from Panels at St. Petersburg

Sampling Date	N, 5°	S, 5°	Air
January 1975			
2 (air, during application of the finish coat)			Aureobasidium Alternaria Helminthosporium Cladosporium
3 0 hr	Aureobasidium Curvularia Alternaria Thyrostromella Epicoccum Cladosporium	Curvularia Aureobasidium Epicoccum 2 n—s*	Curvularia Nigrospora
4 hr	Aureobasidium Alternaria Geotrichum Epicoccum Cladosporium	Aureobasidium Cladosporium Epicoccum 1 n—s	Curvularia Thyrostromella Cladosporium
8 hr	Curvularia 1 n—s	Cladosporium Fusarium 1 n—s	Epicoccum Pithomyces 2 n—s
12 hr	Alternaria Epicoccum 2 n—s	Aureobasidium Curvularia Cladosporium	Curvularia Penicillium Cladosporium
4	Alternaria Curvularia 1 n—s	Curvularia Nigrospora Aureobasidium 1 n—s	Cladosporium Curvularia 1 n—s
6	Nigrospora Alternaria Cladosporium 1 n—s	Aureobasidium Alternaria Curvularia Penicillium	Aureobasidium Curvularia Pithomyces 1 n—s
8	Aureobasidium Alternaria Nigrospora 1 n—s	(RODACs crushed in mail)	Curvularia Nigrospora
10	Aureobasidium 3 n—s	Curvularia 1 n—s	Aureobasidium Penicillium 1 n—s
12	(crushed in mail)	Aureobasidium Curvularia Nigrospora Epicoccum 1 n—s	(crushed in mail)
14	(shipment lost in mail)		
16	Aureobasidium Cladosporium Penicillium 1 n—s	Aureobasidium Epicoccum	Aureobasidium Bipolaris Cladosporium Curvularia Nigrospora 1 n—s
18	Aureobasidium Nigrospora	Aureobasidium Cladosporium 1 n—s	Cladosporium 1 n—s
25	Aureobasidium Cladosporium Curvularia	Aureobasidium 1 n—s	Aureobasidium Curvularia Penicillium
February 1975			
1	Aureobasidium	Aureobasidium Cladosporium	Cladosporium Curvularia
8	Aureobasidium Cladosporium	Epicoccum Curvularia	Cladosporium Helminthosporium
15	Aureobasidium (95% of RODAC) Trichoderma	Epicoccum	Curvularia Epicoccum Neurospora
22	Aureobasidium Cladosporium	Epicoccum Nigrospora	Curvularia Epicoccum

Table 2—Principal Fungi Recovered from Panels at St. Petersburg (continued)

March 1975			
1	Aureobasidium Cladosporium Epicoccum	Aureobasidium Epicoccum Stemphyllium	(crushed in mail)
31	Aureobasidium 1 n-s	Aureobasidium (90% of RODAC) Helminthosporium Stemphyllium	Curvularia Aureobasidium
May 1975			
1	Aureobasidium (90% of RODAC) Curvularia Aspergillus	Aureobasidium (90% of RODAC) Curvularia Epicoccum Aspergillus	Curvularia 1 n-s
June 1975			
1	Aureobasidium Cladosporium	Aureobasidium 1 n-s	2 n-s

(a) n-s = non-sporulating isolate

BBL Division of BioQuest and are referred to as RODAC (Replicate Organism Detection and Counting) plates. However, since that technique leaves a residual layer of nutrient on the site sampled, a new site has to be sampled at each subsequent sampling time. That is, a site can be monitored only once for microbiological authenticity. However, we were interested in sampling the same site repeatedly to directly index the succession of microorganisms. For this approach, we used sterile, moistened felt pads to replicate the site repeatedly onto agar plates during the first two months of the St. Petersburg study.

We also wanted to be able to assess which of the fungi (and bacteria) recovered by these two techniques were merely casually present on the sampled site and which had established a biological relationship on the film. As mentioned by Allsopp *et al.*,⁴ we felt it was necessary to attempt to sort out the real detriogens from the secondary invaders. Toward this end, the ambient air was sampled during application of the finish coat of paint and for a 10-min period during panel sampling. RODAC plates of both malt agar (M) and brain-heart infusion agar (B) were exposed to recover fungi and bacteria, respectively, from the air (A), N- and S-facing panels.

Although *A. pullulans* is not known to be especially sensitive to temperature changes at the film surface, we nonetheless monitored this parameter of the physical environment. Portable dual-channel recorders (Rustrak Model #21388) were equipped with remote probes (Rustrak Model #1334); probes were taped to the surface so that the sensor side was in intimate contact with the film. We thus have a continuous temperature profile with the sampling time noted on the paper strip. Ultimately, we will attempt to correlate both the film-surface tempera-

ture and the ambient temperature (obtained from climatologic data supplied by the National Oceanic and Atmospheric Agency for both test areas) with microorganisms recovered.

Whereas most fungi can be identified on morphological bases, bacteria require a series of biochemical tests to determine even the genus. Accordingly, bacteria have been characterized to date only to genus on the basis of their cellular morphology, gram-staining reaction, and biochemical tests.

The actual sampling was done for us by Carl Englehardt, Cosan Chemical Corp., at St. Petersburg, and by Frank Tusa, Shilstone Testing Laboratories, at the New Orleans site. RODACs for N, S, and A are taped shut, dated, packaged, and mailed to us in Columbus. Transit time serves as incubation time. Upon receipt, a density evaluation was done for each plate and visually determined if additional incubation of one to two days would be desirable. Subcultures are prepared for the array of fungi and bacteria present on the plates. When colonies were extremely close or overgrown, dilution tubes were prepared and the suspended cells streaked on agar for separation. Stock cultures were prepared. If possible, the fungus was identified to genus, using temporary microscope preparations; if it was impossible to discern the necessary morphological characters from these temporary mounts, a slide culture (Riddell¹⁸) was made and the fungus identified.

Table 2 lists the fungi recovered from panels and ambient air at the St. Petersburg site. Table 3 shows similar data for the New Orleans location. Inspection of the data from these tables will reveal the presence of a somewhat different mycoflora at the two sites. We should point out that the abundant inoculum of airborne *A. pullulans* cells during

Table 3—Principal Fungi Recovered From Panels Near New Orleans

Sampling Date:	N, 5°	S, 5°	Air
January 1975			
24 during application of finish coat			Pleospora
25 0 hr	Pleospora Stemphyllium 2 n—s ^a	Pleospora Stemphyllium 2 n—s	Pleospora Stemphyllium 2 n—s
4 hr	Pleospora Epicoccum	Epicoccum	
8 hr	Pleospora Epicoccum	Epicoccum 1 n—s	Cladosporium Epicoccum Alternaria 1 n—s
26	Epicoccum 1 n—s	Epicoccum Pleospora 1 n—s	Pleospora Cladosporium Epicoccum Helminthosporium
29	Epicoccum Cladosporium 1 n—s	Pleospora Epicoccum	Pleospora 2 n—s
30	Pleospora Cladosporium Epicoccum	Epicoccum Cladosporium 1 n—s	Aureobasidium Cladosporium 3 n—s
February 1975			
1	Epicoccum	Epicoccum Cladosporium	(not sent)
3	Epicoccum Cladosporium 1 n—s	Epicoccum Cladosporium	(crushed in mail)
5	Epicoccum Cladosporium	Epicoccum Cladosporium Neurospora 1 n—s	3 n—s
7	Epicoccum Curvularia Cladosporium Pleospora	Epicoccum Cladosporium Curvularia	Epicoccum
9	Alternaria Epicoccum Pleospora	Epicoccum	Epicoccum
17	Cladosporium Epicoccum	Alternaria Epicoccum Pleospora	Cladosporium Epicoccum
24	Epicoccum	Cladosporium Epicoccum	Cladosporium Epicoccum Nigrospora
March 1975			
2	Aureobasidium Epicoccum Cladosporium ^b Pleospora Nigrospora	Cladosporium Epicoccum Pleospora	1 n—s
10	Cladosporium Epicoccum	Cladosporium Epicoccum	Cladosporium Curvularia Epicoccum
17	Cladosporium Epicoccum	Aureobasidium Cladosporium Epicoccum	Cladosporium Epicoccum
24	Cladosporium Epicoccum	Cladosporium Curvularia Epicoccum	Cladosporium Epicoccum

Table 3—Principal Fungi Recovered From Panels Near New Orleans (continued)

April 1975			
23	Epicoccum (99% of RODAC) Cladosporium	Epicoccum (99% of RODAC) Cladosporium Aureobasidium	(crushed in mail)
May 1975			
24	Agar stuck to top of RODACs, creating anaerobic conditions (no date)		

(a) n-s = non-sporulating

(b) Colonies aligned in rows, simulating grain of wood.

the top-coat application and drying period for the St. Petersburg study probably resulted in many cells being deposited under, in, and on the surface of the film. With this in mind, the early onset of *A. pullulans* infestation might be interpreted in several ways. If indeed the microenvironmental conditions within the film were such that these trapped spores germinated, grew, and elaborated cellulase, the resulting mycelia would have had a head start on growth. To the best of our knowledge, no time study has been reported for the germination of spores to the production of mycelia to the production of spores.

On the other hand, the changing conditions of oxygen-concentration in the drying film could have affected the entrapped and underlying cells of *A. pullulans* and the other fungi recovered. The microaerophilic conditions in the drying film may have killed or induced dormancy in those spores. In this case, early recovery of *A. pullulans* might be explained by: (1) following inoculation of the dried film by airborne spores, subsequent growth of another fungus or bacterium, singly or in combination ("symbiotically"), was able to degrade the film; (2) activation of certain *A. pullulans* enzyme systems on the aerobic film surface; or (3) growth of *A. pullulans* utilizing organic contaminants on the film surface. It is unlikely that spores trapped in or under the film would germinate that rapidly and develop enough mycelium to grow out through the film. The repeated recovery from the St. Petersburg panels of certain other fungi (Table 2) strongly suggests nutritional interrelationships that laboratory enzymatic profiles might clarify. The same is true for the bacterial flora which was remarkably uniform (Table 4). We infer that a complex nutritional network probably exists here that results in at least a visual dominance of *A. pullulans*. Possibly this fungus is a superior competitor for the breakdown products of our paint even though the early actual degradation may be done by other microorganisms. Winter (personal communication) claims *Alternaria* sp. elaborates cellulase as a constitutive enzyme.

It is evident that it is difficult, if indeed desirable, to attempt to draw inferences on fungal suc-

cession on the basis of the data shown. Clearly, additional studies during different seasons and at other test-fence sites need to be made, after which correlation of all data may reveal a pattern. Ideally, data derived from our present and proposed future studies will permit the derivation of a model for the microbial succession resulting in MIDOC.

One thing has become clear, as a result of these preliminary investigations: it is imperative that identification of the fungal components of MIDOC must be made from cultures derived from the RODAC plates, not directly from the RODAC plates themselves. In order to be able to identify a fungus, it is necessary to see the relationship of the conidium (spore) to the hypha producing it (the conidiophore). It is also necessary to determine if the conidia are produced singly or in chains. For most fungi, these determinations cannot be made directly from the RODAC plates.

Another pitfall came to light during this study, namely, that almost perfect superimposition of colonies of two different microorganisms can occur and does occur rather commonly. Such situations arise from the close proximity of the propagules of the two fungi or the bacterium and fungus on the film surface. Repeatedly, we have found a highly mycelial fungus almost totally masking the presence of an underlying organism. Many of the *A. pullulans* colonies from the St. Petersburg site were overgrown by another fungus and could have been overlooked easily, had we relied on only the 30 \times magnification of a dissecting microscope. However, streaking of the spore-dilution media separated them successfully.

Still another problem became evident with the

Table 4—Bacteria Isolated from St. Petersburg and New Orleans Panels (listed in decreasing order of prevalence)

(listed in decreasing order of prevalence)

- (1) *Bacillus* sp. (90% of isolates)
- (2) *Staphylococcus* sp.
- (3) *Corynebacterium* sp.
- (4) *Streptococcus* sp.
- (5) *Pseudomonas* sp. (less than 1%)

New Orleans material. We repeatedly recovered a fungus simulating *A. pullulans* in colonial characteristics and even possessing similar-appearing pigmented, thick-walled pseudohyphae, but which also formed what appeared to be immature ascocarps. Subsequent study of more mature material revealed mature ascocarps and ascospores; the combination of characteristics is typical for the genus *Pleospora*. Ascocarps are specialized arrangements of hyphae (the size and shape will vary with the fungal species) within which hyphal and nuclear fusions result in sexual reproductions, the culmination of which is the production of special spores, the ascospores, within specialized cells. The detection of this sexual stage is of considerable mycological interest, but has no great impact on MIDOC, since there is no or only little evidence that the sexual phase develops on the coating. Yet, the casual observation of the colony on the RODAC plate and the early growth *in vitro* lead us to tentatively identify it as *A. pullulans*.

Many of the genera of fungi listed in Tables 2 and 3 include species which are plant pathogens. Despite the rather different nature of the locales where the test fences are located (a residential/light industry area in St. Petersburg; an agricultural area with citrus groves on three sides and greenhouses for tomatoes to the north near New Orleans), we are recovering many of the same genera at both sites. No attempt has been made to ferret out the source of these phytopathogens and their respective host species in the environs of the test fences, since their origin is not germane to the present investigation.

These successional studies have indicated several things clearly: there are a variety of fungi impinging on the coating; the recovery procedures do not permit a differentiation between those fungi actually growing on the film and utilizing it as an energy source (i.e., a detriogen in the terminology of Allsopp *et al.*,⁴) and those fungi which are represented merely by the casual occurrence of a propagule (conidium or hyphal fragment) on the surface at the time of sampling. Although monitoring the ambient air at the time of panel sampling is an index, it only indicates those organisms represented in the aeroflora during that 10 min period. The approximation is better than no index at all, but suf-

fers from the same single-sampling deficiency inherent in the typical, one-shot panel sampling procedures. In a personal communication from R. A. Smith (Abbott Laboratories) one of us (JAS) has learned that the surface sterilization of the surface to be sampled has little effect on the fungi recovered; basically, the same genera — *Aureobasidium*, *Cladosporium*, and *Alternaria* — emerge as the principal offending forms.

Another area where more exploratory trials need to be carried out concerns the type of nutrient agar used for the RODAC plates. The malt agar and brain-heart infusito agar used in the present study are not especially selective; the Brain-Heart Infusion Agar (BHIA) will support the growth of both fungi and bacteria, while fewer bacteria can utilize malt agar than BHIA. Truly selective media are being developed through the use of an antibacterial antibiotic in the medium for recovery of fungi, and the incorporation of an antifungal antibiotic for the bacterial medium.

ACKNOWLEDGMENT

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Fluorinated Polyepoxy And Polyurethane Coatings

DONALD E. FIELD
Naval Research Laboratory*

A continuing basic research program on the synthesis of fluorinated polymers has provided materials with some unusual properties. Among these properties are superior heat, light, and chemical resistance and low surface energies. In addition, the fluorinated polyol is soluble in common solvents, from which they can be applied to a surface where they can be converted by chemical reactions in situ into continuous coatings of a thermoset nature. Such coatings were made from a fluorinated aliphatic and aromatic diol condensed with epichlorohydrin to produce fluorinated polyols. These soluble polyols were then crosslinked with a commercially available polyisocyanate. The soil- and corrosion-resistant properties of these coatings have made them of particular interest to the Naval Air Systems Command as coatings for aircraft.

KEY WORDS: Crosslinked fluoropolymer coatings; Fluoroepoxy and polyurethanes; Aircraft coatings; Soil-resistant coatings; Low surface energy coatings.

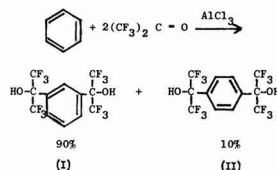
INTRODUCTION

From fluorinated precursors we have synthesized polymeric materials composed of network molecules such as epoxies and polyurethanes. These tough, chemically resistant substances are, in effect, a new class of materials, inasmuch as the presence of large amounts of fluorine confers properties not commonly found in such polymers. These easily applied coatings have been tested and proven useful as protective, soil-resistant paints for aircraft, and have utility in many other applications because of their unique physical properties.

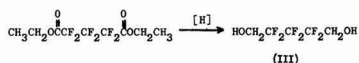
GENERAL SYNTHESIS

Griffith¹ and co-workers at this laboratory initiated a basic research program to synthesize fluorinated polymers for adhesives, structural plastics,

and composites which had water resistance and high temperature stability. The basic materials were diepoxides which were made from fluorinated aromatic diols and a large excess of α -epichlorohydrin and were crosslinked with polyamines. Later it was suggested that longer chain polymers containing hydroxy groups could be synthesized and crosslinked with diisocyanates.² Polyols synthesized from aliphatic and aromatic fluorinated diols with an equivalent amount of epichlorohydrin can be crosslinked with polyisocyanates at room temperature to form films and coatings having exceptional physical properties.³⁻⁶ The aromatic diol was a mixture of 1,3- and 1,4-bis(2-hydroxyhexafluoro-2-propyl) benzene (I and II), prepared using the synthesis of Farah, et al.⁷



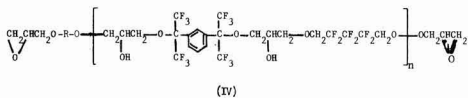
The aliphatic diol, hexafluoropentenediol (III), was prepared by the reduction of the diethyl ester or chloride of perfluoroglutaric acid by the method of McBee, et al⁸ using either LiAlH_4 or sodium bis-(2-methoxyethoxy) aluminum hydride as the reducing agent:



The aromatic and aliphatic diols (I, II, and III) were reacted with an equivalent amount of epichlorohydrin and a 10% excess of sodium hydroxide to form a high-molecular-weight polyol (IV) where n is greater than 1 and where the epoxy end groups are widely spaced and not as available for crosslinking as the hydroxyl groups. If a large excess of epichlo-

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* Washington, D. C. 20375.

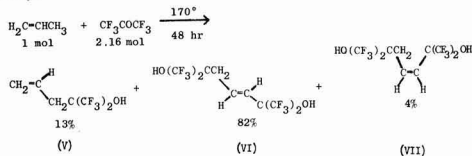
rohydrin is used, a diepoxide (IV) is formed where n is approximately equal to 1; these low-molecular-weight polymers are capable of being crosslinked through the epoxy end groups.



where R equals $-\text{C}(\text{CF}_3)_2\text{PhC}(\text{CF}_3)_2-$ or $-\text{CH}_2(\text{CF}_2)_3\text{CH}_2-$

All of these epoxy and polyol polymers are obtained in yields of 87-97% and are light amber solids.

The recent scarcity of the aliphatic diol (III) and its resulting high cost led to a research program to find a suitable substitute. It was found in the literature that hexafluoroacetone reacts with olefins to form mono, di, and triols,⁹ and one particular reaction, that of propene and hexafluoroacetone, gave a yield of at least 86% of cis and trans diols (VI and VII).



The procedure used to make the new cis and trans diols (VI and VII) was to bleed the gases into evacuated, lightweight pressure bottles cooled in a dry ice-acetone mixture until the proper weights were obtained. These bottles were attached to an evacuated, dry ice-packed autoclave, then heated with a hot-air blower to force their contents to condense in the autoclave. The autoclave was heated with stirring at 170°C for 48 hr, and cooled before removing the reactants. The mono alcohol (V) was stripped from the diols (VI and VII) by distillation.

The general procedure for synthesizing the polyurethanes is to reflux the diols (I and II or with either III or VI and VII) with epichlorohydrin and sodium hydroxide in a solution of acetone containing a small amount of water. Samples are taken periodically and injected into a gas chromatograph for analysis; the reaction is complete when the peaks for the two diols have disappeared.

Upon completion of the reaction, most of the acetone is stripped from the viscous polymer which is then poured into a large excess of distilled water. The mixture is heated, stirred, then cooled, and the wash water is decanted. Washing is continued until the water is free of base. The polymer is dried in a 120°C oven, dissolved in solvent at 50% by weight, and filtered.

In most cases, the solvent consisted of a 20:20:60 vol % blend of ethyl acetate — methyl isobutyl ketone — ethylene glycol monoethyl ether acetate. This solution, after addition of polyisocyanate and

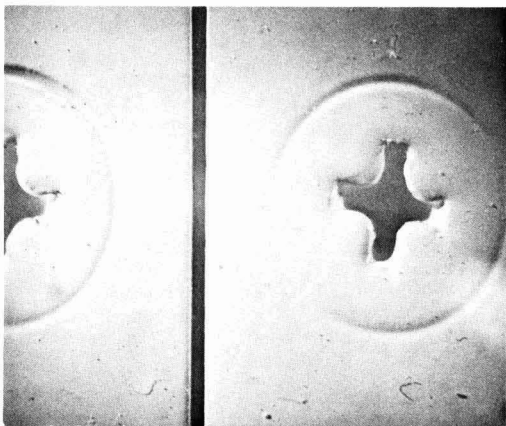
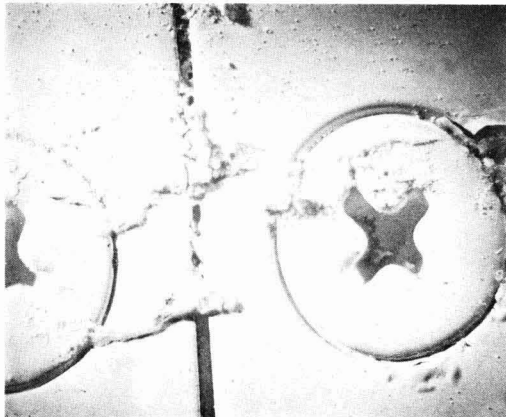


Figure 1—Fastener assembly exposed to salt fog test; MIL-C-81773A/AS polyurethane (top) and the fluorinated polyurethane (bottom)

catalyst, is of a good brushing viscosity. Pigmented coatings and those applied by spray gun require the addition of more solvent. Pigments are dispersed in these resin solutions (of IV) by common paint manufacturing procedures, such as pebble milling. Titanium dioxide, carbon black, and phthalocyanine blue have been used; however, most common pigments should disperse satisfactorily.

Since these polymers have surface energies of about the same magnitude as polytetrafluoroethylene (Teflon®), finely ground Teflon can be readily incorporated to form paints of high fluorine content which are extremely hydro- and organo-phobic.

The polyol and polyisocyanates are usually mixed in equivalent weights (NCO to OH ratio equals 1 to 1) and the reaction forming the cross-linked polyurethane takes place on the substrate at room temperature.

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Metal panels used as substrates in coating studies were Alclad 2024-T3 and 7075-T6 aluminum. The panels were cleaned, deoxidized, and treated with a chromate conversion coating before applying 0.6 to 0.9 mils of primer (MIL-P-23377, a strontium chromate pigmented epoxy polyamide) and 1.0 to 1.5 mils of topcoat.

Although these fluorinated urethanes have excellent adhesion to epoxy-polyamide primers and to themselves even after aging, they have poor adhesion to bare, untreated aluminum. Fluorinated primers have not been considered at this point because of the additional cost of the paint system.

A more detailed description of the synthesis of these resins may be found in the patent literature.^{5,6} Detailed information is also available on the synthesis of the diols (V, VI, and VII).⁹ Patent applications have been made pertaining to the synthesis of polymers using these latter diols.

RESULTS AND DISCUSSION

Although some research has been conducted on the synthesis and formulation of amine-cured primers based on the diepoxide (III) formed when excess epichlorohydrin is used and $n \sim 1$, most of the research to date has been on the development of clear and pigmented topcoats based on the same structure where $n > 1$. Most of these higher molecular weight polyols have been crosslinked with Desmodur[®] N-75, a triisocyanate obtained by the reaction of 3 mol of hexamethylene diisocyanate with 1 mol of water. This triisocyanate imparts extremely good light-stability and weather resistance to urethane coatings.¹⁰ The catalyst used was dibutyl tin dilaurate in concentrations of 0.015% to 0.07%, based on the triisocyanate, to give the desired pot-life.

Evaluations of these topcoats were made in comparison with the specified aircraft acrylic (MIL-L-81352), epoxy-polyamide (MIL-C-22750C), and aliphatic polyurethane (MIL-C-81773A/AS) coatings. These coatings were subjected to more than 15 tests (as specified in MIL-C-81773A/AS) to evaluate their durability as compared to the above coatings, and proved superior in every way. Coatings made from the new cis-trans diols as a substitute for the hexafluoropentane diol have been equal to their predecessor or superior in resistance to water, oil, and soil. Early outdoor exposure tests and Weather-Ometer[®] results indicate that they are equivalent in weather durability.

In addition to the tests specified for aliphatic polyurethanes in MIL-C-81773A/AS, a series of corrosion test specimens was prepared by coupling 7075-T6 aluminum panels to 2024-ST aluminum blocks with a pattern of six cadmium-plated steel fasteners in a manner used in aircraft construction.

DONALD E. FIELD joined the Naval Research Laboratory's Chemistry Div. in 1951 after receiving his B.S. Degree in Chemistry from Virginia Polytechnic Institute. His research has been concerned with polymers and plastics and, since 1958, with their application to paints and coatings.

However, no sealant was used during assembly, thus enabling corrosion to proceed more rapidly and to compare the protection of the coating systems by themselves. These specimens were stressed and exposed to 500 hr of 5% salt fog and an additional 1000 hr to acidulated salt fog (ASTM: B287-62). *Figure 1* shows that the fluorinated polyurethane on the bottom remained intact, while the specified (MIL-C-81773A/AS) polyurethane on the top suffered cracking around the fastener, with resulting corrosion.

For primary service evaluation, the surfaces of two engine hatches of one of NRL's C-121 Constellations were painted with the fluorinated urethane coating systems. *Figure 2* shows the results after one year of flight operations. After washing the test and surrounding areas with MIL-C-22543 cleaner, it was found that both the clear and pigmented NRL coatings were more readily cleaned than adjacent urethane paint and resisted permanent "burnt-in" soil from hot exhaust gases and engine oil.

USES AND POTENTIALS OF FLUORINATED COATINGS

The major deterrent to the use of fluorinated coatings is their high cost. This factor precludes their use as a general purpose coating at the present time. However, this laboratory and other researchers have found uses for these coatings where either they have great merit or where no other coating system will qualify.

First among the unique and special uses for the fluorinated polyurethane is as an inert coating for a 30 × 30 ft environmental test chamber used for a study of automobile exhaust emissions. Among the necessary physical properties for the coating were low surface energy, no degradation from ultraviolet radiation, no absorption or outgassing of vapors, and ease of cleaning between experiments.

An evaluation by the Calspan Corp. of candidate coatings concluded that only Teflon and the NRL fluorinated urethane would meet all of the required criteria. Teflon was eliminated from consideration since no practical method of application was available.

Figure 3 shows how the chamber looked after brush application of a 2-mil (dry) coating of the fluorinated polyurethane over a reflective undercoat. This coating has maintained its unique properties after repeated tests and washings and is still in use after three years of service.

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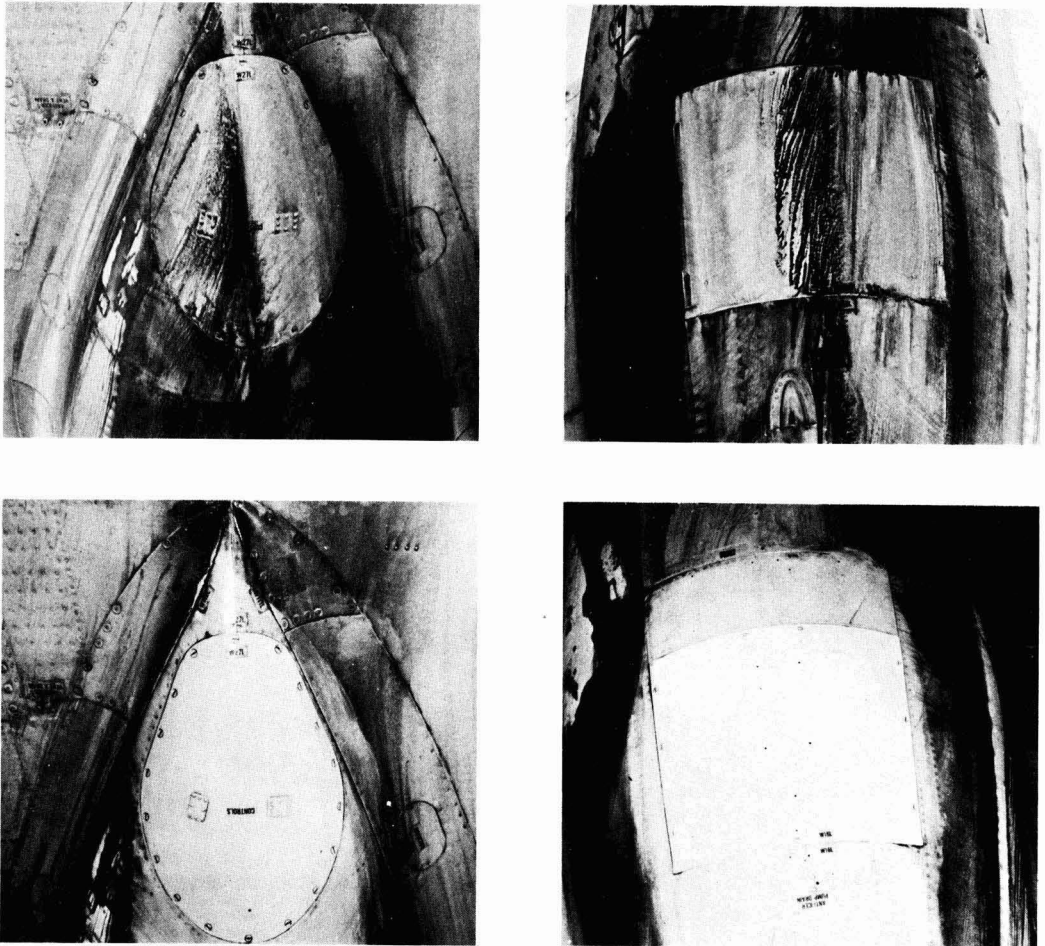


Figure 2—Soil resistance and ease of cleaning are evident on two engine hatches of a C-121 Constellation after a year of flight operations. The oval panel was coated with the clear fluoropolyurethane and the rectangular panel was coated with the same resin pigmented with Teflon

A rather interesting and potentially useful application for the Teflon-filled fluorinated polyurethane is as a barrier film for marine boring organisms. Recent studies by Dr. John D. Bultman of the Ocean Sciences Div. of NRL have shown that barrier coatings of this material were not penetrated by pholads and teredos.

Pine panels were coated with experimental paints which were coupled with untreated pine bait pieces to provide suitable substrates in which settling borer larvae could metamorphose into adults. These sandwich arrangements were exposed to tropical sea water in the Bay of Panama for five months to test whether adult borers could penetrate or perforate the experimental coatings from the untreated wood.

Figure 4 shows that the fluorourethane coating prevented borers from passing into the coated wood

from the bait pine. The surface markings visible on the panels are etchings caused by teredos as they broke through the bait pine, and tunneled back into it rather than continue on through the coating. At this time it is not known whether the physical nature or chemical toxicity of the coating was successful in repelling these animals.

There are several examples of the unique properties of these polymers. A number of experiments and tests are being evaluated for other potential uses for these coatings. Heavy loadings of Teflon pigment (25-40% by volume) have low coefficients of friction which approach Teflon itself (0.10-0.19 static and 0.04-0.08 kinetic) and these coatings have shown promise as low-ice-adhesion paints.

Unpigmented coatings are presently being evaluated and early test results indicate that they have great potential as a hydrophobic coating for peri-

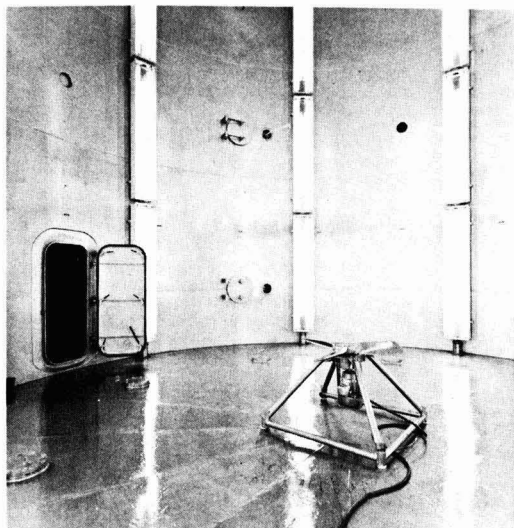


Figure 3—High-gloss unpigmented fluoropolyurethane coating on the large cloud physics chamber at Calspan Corp.

scope optical windows. Other potential uses for these unique coatings are as a hydrophobic coating for submarine antenna housings; low soiling, easy-to-clean paint for static discharge voltage multipliers on certain rotary-wing aircraft; durable barrier films for lubricants on certain mechanical devices; barrier films used in the manufacture of circuit boards; coatings to facilitate decontamination of chemical warfare agents; high emissivity coatings for space vehicles; and specialized anticorrosive coatings for certain military hardware, such as ship antennas and submarine missile base-rings which are subjected to hostile environments.

These are just a few of the potential uses for crosslinked fluoropolymer coatings. It is hoped that by establishing a range of applications for these fluorinated urethanes sufficient demand can be developed to interest a commercial supplier in producing them with the attendant economy of large-scale production.

SUMMARY

Fluorinated polymers have proven themselves as superior to their hydrocarbon counterparts in all physical properties tested. These fluoropolymers are unique in that they are soluble in common organic solvents whereby they may be crosslinked to form coatings of extreme durability. Although cost is a factor in their use at present, they have found uses where other coatings will not meet the requirements or where their use reduces the long-term cost to less than the best of competitive coatings.

ACKNOWLEDGMENT

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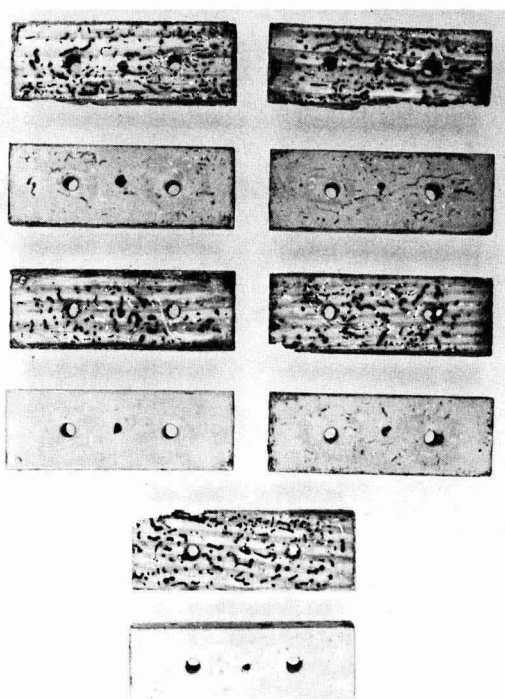


Figure 4—Fluoropolyurethane-coated panels and pine balt pieces. Surface etching of the coated panels was caused by teredos

Review of Factors Determining Solubility and Absorption of Lead And Other Trace Metals In the Gastrointestinal Tract

DARLENE R. BREZINSKI
DeSoto, Incorporated*

The feasibility of establishing laboratory *in vitro* methods of simulating the gastrointestinal processes so as to determine the extractability, solubility and absorption of metals from a paint matrix is investigated. Particular emphasis is given to lead, its properties and chemistry. An attempt is made to present the many aspects which need to be considered for the purpose of establishing a laboratory method. Hence, a brief description of the digestive system and the physiology of the gastrointestinal tract is outlined and aspects which affect digestion are considered. Other factors which affect the absorption of metals are described: chelation, membrane permeability, solubility and particle size. Some aspects of current animal feeding studies are also cited.

KEY WORDS: Lead, absorption of in the gastrointestinal tract; Toxicity; Enzymes; Metal sulphides.

INTRODUCTION

It is in the past 20 years that the literature begins to reflect the interest of biochemists, physiologists and pharmacologists in intestinal absorption, particularly of metals. Predominant interest has focused on the so-called 'essential metals'. The past five years have witnessed an awakening in the recognized, or potential toxicity of trace elements in biological media.

All of us would agree that the ingestion of old lead-based paint presents a definite health hazard to children. Medical researchers, paint manufacturers and legislators, recognizing the seriousness of the problem have endeavored to establish safe concentrations of lead in paint. There is much reported in

the literature in terms of animal research and clinical observation, however, most of the data are based on the old white lead paints or soluble lead salts which are not representative of today's paint formulations. There have been studies reported in the literature indicating that lead compounds are not readily leached from today's paint films. Before safe concentrations of lead — or any metal — can be intelligently established, we must be able to evaluate its toxicity *as it currently exists* in a modern paint.

The present investigation was precipitated in conjunction with an ASTM committee and because of a growing concern by the coatings industry regarding increased and/or pending legislation pertaining to toxic elements. The primary concern facing all industries with marketable products is the bioavailability of the product or components of that product. Quite obviously it is not feasible to use human subjects as the standard reference material, hence the widespread use of animal models. It would be ideally convenient and economical to develop laboratory methodology which could ascertain the bioavailability of elements of concern, particularly heavy metals with potential toxicity. A laboratory method which could serve to obviate the necessity of very costly animal feeding studies and shed some light on future applications and raw materials would be most desirable. The purpose of our work was to investigate the feasibility of establishing such a method for lead based coatings and other metals or compounds of future concern, a method to serve as a guide to assess potential toxicity and bioavailability particularly for legislative action. In so doing, we became increasingly aware of the many parameters which need to be considered concerning the physiological organism, the metal and the

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* Administrative & Research Center, 1700 S. Mt. Prospect Rd., Des Plaines, Ill. 60018.

interactions that may occur. Obviously any methods which are developed need to have demonstrated correlation with *in vivo* studies.

Any method concerned with the solubility of a given metal in the gastrointestinal tract, has to be considered from the point of view of the metal in a common system, i.e. the solubility of the metal in body fluids, its tendency to complex, its solubility as a function of pH, its hydrated size, its ionic radius and its electrochemical characteristics. These properties, which vary from metal to metal, are important considerations in any given procedure. Inasmuch as lead in paint was the metal of interest, our discussion concerns lead.

Most heavy metals are not freely soluble in an ionized form under biological conditions. This is because of the ability of most cations to form coordination compounds with many ligands commonly present in biological media and in foodstuffs at physiological hydrogen ion concentrations.

In mammals and man, a trace element can be defined as an element constituting less than 0.01% of the body's mass. The 50 or more trace elements found in the body make up less than 0.2% of total body weight. The most abundant trace elements are iron, fluorine and zinc.¹ There are 12 trace elements which are recognized as performing functions essential to the life or health of the living organism. Six are recognized to be essential for all forms of life: manganese, iron, cobalt, copper, zinc, and molybdenum.

In general, there are two kinds of abnormalities which frequently are associated with trace metals: a specific deficiency, frequently resulting from a dietary inadequacy or imbalance and secondly, an accumulation of innately toxic trace metal which can either replace essential metals from their active sites or may act directly as cellular toxins.

A number of nonessential trace elements have been found in human body tissue. Nine of the non-essential trace metals have been classified as toxic:

Cadmium	Arsenic
Lead	Barium
Mercury	Tellurium
Antimony	Tin
Beryllium	

Thus far, the following have not been determined toxic in the amounts normally present in tissue: aluminum, bromine, boron, rubidium, titanium, zirconium, niobium and lithium. All elements may be toxic in all living organisms if large amounts are present.¹

The metals of most concern today are those which can be related to human disorders, are accumulative and are present in small concentrations in the environment. For mammals, the order of acute toxicity is As > Cd, Hg, Pb, Sb, Be > Sn and Ba. For rats and mice which were fed low doses for laboratory experimentation, the order of toxicity is: Methyl Hg > Pb > Cd > Sb > Sn > Be ≈ Ba > As.¹

To discuss or define 'toxic element' is in itself an enormous undertaking, subject to debate and dispute. The concept of toxicity has changed during the last few decades due to the increased knowledge and awareness that the usual criteria such as pathology, weight changes, carcinogenicity, fertility and hematology do not necessarily reflect the more subtle long term effects such as birth defects, genetic aberrations and so forth.²

When a nonessential or 'toxic' metal has the same electrochemical properties and similar structural properties (ionic radius, etc.) as that of an essential metal, it can become biologically antagonistic. It is potentially capable of stimulating or inhibiting the function of an enzyme.

Lead forms di- and tetravalent compounds, the divalent being the most common. Lead (II) compounds are primarily ionic and form well defined basic salts and complex mixed salts. Tetravalent lead compounds are considered covalent. The lead (IV) compounds are strong oxidizing agents, consequently the lead (IV) ion does not exist in solution. Most solubility data currently available for lead is determined for an 'ideal system', i.e., the solubility of pure salt in water, or in some cases dilute acids, at standard temperature (18, 20, or 25°C). Unfortunately, these are not the conditions found within the gastrointestinal tract.

The most common variables influencing solubility are temperature, pH, particle size, agitation rate, reagent concentration, salt concentration, solvent and matrix composition.

Lead sulfate and lead chloride exhibit an increase in solubility in an aqueous system with a ten degree temperature increase. Because solubility is influenced by temperature for most compounds, it is important to keep in mind that gastric solubility occurs at body temperature (37°C) which is significantly higher than most solubility data obtained at standard conditions (20°C).

Lead sulfate also exhibits an increase in solubility in acid solution, whereas lead chloride shows no significant increase in dilute hydrochloric acid; this is most probably due to the common ion effect caused by chloride ion. Lead carbonate would be expected to show a large increase in dilute hydrochloric acid due to the formation of the gaseous product, carbon dioxide. Lead chromate is also more soluble (a thousandfold increase) in dilute acid, and shows a twofold increase in solubility with increasing temperature.

It is difficult to make any statement regarding the solubility of lead salts in serum because of the complex nature of serum. Serum is a well buffered solution and one in which hydrolysis, complex formation and common ion effects need to be considered. Lead carbonate is approximately 300 times more soluble in serum than in water, lead oxide approximately 100 times more soluble and lead sulfate approximately as soluble in serum as in water. No

comparable tabulation of solubility in gastric fluids could be found in the literature.

Lead has been detected in all tissues of man and animals. The major source of lead ingestion is food, water and beverages. It has been documented that man receives an average of 300 micrograms of lead per day in food. The range lies between 100 to 400 micrograms.³ A study was done by Kehoe⁴ in which total food ingested (food, water and beverages) and total excreta were analyzed for lead. This net balance of intake versus output was studied over a period of months. The results indicated that excreted lead frequently was higher than ingested lead. The amount of lead assimilated through respiration was immeasurable and thought to account for the results.

Most of the knowledge we have concerning the biological effect of lead poisoning is based on a study of those individuals with overt poisoning or animals administered high dosage forms of lead. Lead poisoning is well known but it exhibits fairly nonspecific symptoms of illness in man unless it reaches an acute poisoning state. Symptoms include anemia, colic, renal impairment and a general feeling of tiredness — characteristics common to many living in a 'fast-pace' society. A clinical description of lead poisoning may be found in texts⁵ or reviews.^{6,7}

There is no evidence that lead is an essential trace element, but it is possible that minute amounts may serve some essential metabolic function. All experimental data obtained *in vitro* and *in vivo* show that the metabolic effects of lead in concentrations as low as 10^{-6} M are inhibitory or adverse. Postmortem analyses of tissue for lead indicate that ~95% of total body lead is stored in bone and the distribution of lead in bone follows the movement of calcium.^{8,9}

Some studies seem to hint that lead may inhibit the utilization of iron. At the enzyme level, the inhibitory effect of lead on sulfhydryl dependent enzymes has been documented.⁴ Lead can also form complexes with groups other than disulfide and sulfhydryl.

In a study of toxic metals, it is well to keep in mind that there is generally a balance between the ingested metal and that excreted. Often a relationship exists between metal concentration in blood and urine; therefore, monitoring these concentrations is a useful method of analysis. For some metals, such as mercury, a parallel between urinary and blood concentration does not exist.¹⁰

Limited experimental data shows that the interaction of lead and other metals (Fe, Mn, Cd) may be important. It is claimed that the metabolism of calcium and lead in the body are similar even to the extent that one may affect the other.¹¹ Variations in lead metabolism in individuals plus differences between individuals, may be explained by unrecognized

and/or uncontrolled factors in calcium metabolism. The populace today is simultaneously exposed to a multiplicity of potentially harmful agents — inorganic and organic. Therefore, thought must be given to the consideration that actual toxicity may be greater — synergistic — than that indicated by a study of the agent and its effects in isolation.² Synergistic effects have been postulated for cadmium, iron, and calcium levels and lead toxicity.^{12,13}

The presence of lead as a coordination compound may be a determining factor when considering the availability of lead for absorption and the transfer across the mucosal cell. Therefore, it is important to know in which form lead, or any metal, is available for absorption and whether ligands exist in mucosal cells which may be vehicles for absorption or inhibition.

DIGESTION AND PHYSIOLOGY OF THE GI TRACT

Digestion refers to the process of altering the physical state and chemical composition of orally ingested substances. These changes are brought about in the alimentary canal and ultimately involve the work of enzymes.

The organs of the digestive system form a tube — the alimentary canal or gastrointestinal tract — through the ventral cavity of the body. The main digestive organs are the: mouth, pharynx, esophagus, stomach and intestine. Several accessory organs which are located either in the main digestive organs, or secrete directly into the GI tract, also aid the digestive process: teeth, tongue, salivary glands, pancreas, liver, and gall bladder.

Food taken into the mouth is broken into smaller pieces by chewing. The extent to which food is chewed varies considerably. In some mammals such as the dog and cat, food is reduced in size only enough to permit easy swallowing. In man however, particles are usually reduced to a few cubic millimeters, but this is dependent on the type of food, conversational patterns, early home training, etc.

As food is chewed it is mixed with saliva, the first of the digestive fluids. The average pH of saliva may vary from 5.45-6.06 pH units. On stimulation, pH rises by approximately 2 units to a maximum of 7.8. Saliva is a very dilute solution, the precise composition of which, in the human subject, is not easy to determine with great accuracy. The chief inorganic salts found in saliva are sodium and potassium chlorides. Also present are thiocyanate, calcium, and fluoride. Other organic constituents are urea, uric acid, creatinine, and ammonia which are present in small amounts.¹⁴ The first of the digestive enzymes is also secreted in saliva — ptyalin. This enzyme has a pH optimum from 5.5 to 6.5 and is rendered inactive by the high activity of gastric juice. Therefore, the importance of ptyalin as a digestive enzyme is relative to the length of time food remains in

the mouth. The most important function of saliva seems to be to moisten and lubricate the food for swallowing, and to initiate the digestion of starch to dextrans and maltose as much as possible.

When food is swallowed it passes through the pharynx and esophagus, both of which aid in the digestive process, and on to the stomach. The stomach serves two main functions. It acts as an immediate receptacle for food and is a reservoir for food until it can be passed on in small amounts to the duodenum. The stomach is also the first site of major enzyme action. The absorptive function of the stomach is relatively small.

Once in the stomach, food is mixed with gastric juice secreted by many small tubular glands located in the walls of the stomach. Gastric juice is a pale yellow strongly acidic solution containing water, inorganic salts, mucus, enzymes and hydrochloric acid. In addition to sodium, potassium and chloride ions, calcium bicarbonate, phosphate, and sulfate are also present.

The most important enzyme in the gastric secretion is pepsin. Its maximum action is between pH 1 and 3. Pepsin initiates the hydrolysis of large protein molecules and loses catalytic activity on neutralization.

Analysis of gastric juice collected from the stomach indicates that composition is a function of the rate of secretion. As the rate increases, the hydrogen ion concentration increases, sodium ion decreases and chloride remains fairly constant. At the highest rates of secretion, the stomach contains almost a pure isotonic solution of HCl with small amounts of NaCl and KCl. Secretion rate is dependent on the amount of food substance to be digested.

The mixing action of the stomach musculature and the process of digestion produce a liquid called 'chyme' which passes through the pyloric opening into the intestine. The rate at which the stomach empties is governed chiefly by the influence of chemical and physical properties of chyme in the duodenum: The properties of chyme that affect the rate of emptying include its physical state, the fineness of division of its particles, its osmotic pressure, its acidity and its volume. In general, solutions or suspensions of small particles leave faster than lumps.¹⁵ For an ordinary mixed solid and liquid meal, an average of approximately four hours is required to leave the stomach.

Structurally, the small intestine is approximately 1 in. in diameter, 20 ft in length and can be divided into three sections: duodenum (~10 in.), jejunum (~8 ft), and ileum (~12 ft). By contrast, the large intestine is about 2½ in. in diameter, 5-6 ft in length and may be divided into the following sections: cecum, colon and rectum.

In the first portion of the small intestine — the duodenum — the acid chyme is neutralized by the alkalinity of the pancreatic fluid. Both pancreatic

juice and bile are secreted directly into the duodenum. Pancreatic juice has two major components: an alkaline fluid and three major enzyme groups. About 200-800 ml of alkaline fluid is secreted per day and contains a high concentration of bicarbonate which neutralizes acid entering the duodenum and helps regulate the pH of intestinal contents.

The liver secretes between 250-1000 ml of bile daily which contains acids. These are conjugated with amino acids to form salts. Bile salts recirculate from the intestine to the liver twice during the course of a meal.¹⁶ Bile salts are powerful detergents; they assist in emulsification, hydrolysis and the absorption of fats.

The major part of digestion and absorption occurs in the duodenum and jejunum; undigested and unabsorbed residues are delivered to the colon. The absorptive capacity of the digestive tract depends on the rate of passage. Chyme moves slowly through the small intestine at a rate such that the residue of one meal leaves the ileum as another is entering the stomach. Complete passage through the alimentary canal takes approximately 44 hr.¹⁶

The study of physical and chemical digestion by the GI tract and absorption presents many problems. At this time it may be impossible to design laboratory techniques in which the experimental conditions are controlled, while at the same time maintaining the physiological conditions of the stomach and intestine. In the study of absorption, two different methods are acceptable for use: *in vivo* and *in vitro*. In the *in vivo* method, the intestine is studied *in situ* in the animal. In the currently acceptable *in vitro* methods, the intestine, or a section thereof, is removed from the body and placed in a saline solution and studied.

ENZYMES

Chemical digestion, which ultimately involves the hydrolysis of foods, is catalyzed by a group of organic compounds called enzymes. Enzymes have been shown to be either pure protein or largely protein. The nonprotein portion may contain inorganic ions, i.e. Mn, Fe, Co, Zn, Cu, Mg, etc.

Since enzymes are protein, they have many of the same chemical properties of proteins. Most are soluble in water, dilute salt solutions and dilute solutions of alcohol in water. They become insoluble in water containing increasing proportions of alcohol, are salted out of aqueous solution by neutral salts and are precipitated or coagulated by various agents such as high temperatures and salts of heavy metals.

It is characteristic of enzymes, and other proteins, to contain an alkyl side chain which is ionizable — groups such as —COOH, —NH₂ and —OH. Under suitable conditions of acidity these groups ionize into charged groups. i.e. COO⁻, NH₃⁺, O⁻.

In a physiological solution many ionizable side groups exist in charged forms so enzyme molecules may contain a considerable number of positive and negative charges. These charged groups tend to bind metal ions and the binding of such ions may have an effect on enzyme action.

There are many different ways of classifying enzymes. Most are based chiefly on the type of chemical reaction catalyzed.

(a) Hydrolyzing enzymes (hydrolases) — the digestive enzymes belong in this group, and they are generally named after the substrate acted upon, i.e. lipase, sucrase, maltase, etc.

(b) Oxidation — reduction enzymes — all physiological work and energy release depends on these enzymes.

(c) Hydrases — enzymes which add water to a molecule.

(d) Phosphorylating enzymes — those which add or remove phosphate groups.

(e) Mutases or isomerases — enzymes which rearrange atoms within a molecule.

(f) Carboxylases or decarboxylases — enzymes which add or remove carbon dioxide.¹⁷

Most potential poisons of a living organism exert their action by inhibiting enzymes.

i.e. CN^- — reacts with the active metallic center of cytochrome oxidase

CO — complexes with the iron atom of hemoglobin thereby destroying its oxygen-carrying role.

AsO_4^{3-} — resembles phosphate and blocks enzymes.

Any agent, chemical, or species that reacts with the functional groups of proteins may be a potential enzyme inhibitor.

Properties of the metal that may influence the stability of the metal-enzyme complex are: charge, radius, and available bonding orbitals. The properties of the enzyme that need to be considered are: polarizability, size, and basicity.

The stability of the complex is influenced by the size of the ring formed with the metal ion. A number of measurements were made by Schwarzenbach¹⁸ in determining the binding constant of a series of metals with a series of polymethylenediaminetetraacetic acid derivatives as a function of the size of the ring. He found a definite sequence of stability constants depending on ring size. As the number of groups (n) increase, the binding of the metal decreases as can be observed in the data of *Table 1*.

Table 1—Relationship Between Ring Size and Complex Stability

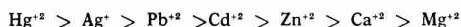
n	Log K			
	Mg ⁺²	Ca ⁺²	Sr ⁺²	Ba ⁺²
2	8.7	10.5	8.6	7.0
3	6.0	7.1	5.2	4.0
4		5.0		
5		4.6		

Table 2—Solubility Product of Some Metal Sulfides

Metal	pK _{sp} (for sulfide)
Hg ⁺²	53
Ag ⁺¹	51
Cu ⁺²	38
Pb ⁺²	29
Cd ⁺²	28

In discussing metal affinity and proteins, it needs to be pointed out that some proteins have a high affinity for certain metals: iron, copper and zinc for conalbumin. The affinity is $\text{Fe}^{+3} > \text{Cu}^{+2} > \text{Zn}^{+2}$ which is also the order of complexing ability of these metals with OH^- ion.

An order of affinity for metals with the sulfhydryl group of serum albumin has been determined.¹⁸



This resembles closely the order of solubility products of the metal sulfides as can be seen from *Table 2*.

It has also been pointed out¹⁹ that often the behavior of one metal is influenced by the presence of other metals or charged species. Each metal ion appears to act and to exist as a participant member of an ionic environment in which metallic and non-metallic ions plus many other complex molecules exist. Therefore, the behavior of a given metal is uniquely dependent on its immediate environment. An appropriate discussion concerning essential metal ion ligands and the interaction between metal ions and ligands can be found in a book by Williams²⁰ concerning the solution chemistry of metal ions.

In discussing trace metals one must keep in mind that the concentration of metal in the entire organ is very small, usually less than a few micrograms per gram. However, the molar concentration of a given metal could be quite large in its particular locale or cellular environment. Very little is known about the physiological mechanisms which regulate tissue concentration of trace metals. The heavy metals in every cell are competed for by an array of natural metal binding agents.

It is held by some that the structure of cell membranes contain, in their associated layers of protein, some highly specialized binding sites such as sulfhydryl, imidazolyl and nucleic acid groups capable of attracting and binding metal ions. The metal cell membrane protein complex may have properties which differ considerably from either the original metal or protein layer. If so, the complex formed may facilitate the passage of metals through the membrane.¹¹

It is also postulated that a cell membrane essentially is a semipermeable membrane structure. There may be some correlation between certain physical properties of metallic ions, i.e. atomic radii, and penetration through a permeable mem-

brane. There is a striking similarity between metals which are known to activate enzymes and those with radii between 0.78-1.03 Å. It is also interesting to note that the size of the hydrated ions of some metals is about equal. Also the second ionization potentials are comparable.¹¹

Foodstuffs can affect the absorption of a metal by their effect on pH, redox activity and the capacity to form metal complexes. Iron and phosphate have a reciprocal influence on availability for absorption. The addition of phosphate to food lowers the absorption of iron, and iron and aluminum reduce the absorption of phosphate.²¹ Oxalic acid of vegetables complexes with many metals and may reduce the availability of the metal for absorption. Other chelating agents that may facilitate or inhibit absorption of metal ions are ascorbic acid, citric acid, and malic acid. There also is an increase of metal absorption in the presence of fructose, and the metabolic products lactic and pyruvic acid. They too can form metal complexes.

The reducing power of foods may influence the absorption of some metals. The acidic gastric medium can reduce Fe^{+3} to Fe^{+2} . Also fruit juice, tomato juice, and vegetables with a high ascorbic acid content can reduce metals. Bread, meat, and eggs are powerful.²²

There is a noticeable lack of methodology to provide information on the physiochemical variables of trace metals and dosage, and how these metals interact with physiological variables associated with the digestive and absorption process. It may be that no single method is adequate. A method which will be sufficiently sensitive and reproducible to quantitate small differences in the dissolution rates of several different salt forms of a metal, may not be appropriate to determine the rate and extent of absorption of these forms in man. A potential hazard exists in extensive human testing, particularly when it concerns an acute form of toxicity.

In the past, the choice of an experimental animal for research has often been made on the basis of cost and convenience. Currently, however, there is an emphasis on choosing animals because of their similarity to man, anatomically, biochemically and/or physiologically. In all probability it may be assumed that no one species of animal will be an exact model for man and no species will respond to toxic poisoning in the same fashion as man. However, many species have organs and/or physiological responses similar to man and these species of animal can be chosen to study toxicity and extrapolate that toxicity to the species *homo sapiens*. This has been discussed in recent years and summarized by Scharding and Oehme.²³

Animals such as mice, rats, and guinea pigs are good to study physiochemical relationships such as salt form, dissolution rates, particle size, etc. Large animals — dogs, miniature pigs, and monkeys — have the advantage of being closer to humans. Prac-

tically, the dog and pig are the best. The GI physiology of the dog is very similar to man with intermittent HCl and biliary secretions. The miniature pig is increasingly favored as a research animal as it is comparable to man in many physiological functions. Being omnivorous, the digestive tract is similar.²⁴

The pharmaceutical industries frequently use physical *in vitro* methods to observe disintegration and deaggregation of tablets and drugs. Attempts are made to correlate *in vitro* with *in vivo* disintegration times. The disintegration test media used is either water or simulated gastric and/or intestinal fluid.²⁵ The simulated fluids are designated by the United States Pharmacopia.²⁶ Sometimes fluids without enzymes are used or buffer solutions with 0.1N hydrochloric acid.

In discussing or proposing methodology, the apparatus used will often differ with respect to: type of agitation, intensity of agitation, dispersion of particles, abrasion of particles, and volume of dissolving fluid.

It becomes increasingly important when proposing standard methods that the above mentioned variables be defined and reproducible. Any attempt to simulate even the simplest of biological organisms cannot be inclusive of all the functional variables whose intricacies form the living cell.

CURRENT WORK AND METHODOLOGY

The scope of current investigations concerning toxic elements is so vast that to cover these would be a monumental task. At times contradictions, or seemingly contradictory interpretations, of experimental data occur.

Gage and Litchfield²⁷ investigated the migration of lead from paint films on passage through the rat gastrointestinal tract. The paint used was an off-white gloss finish based on an oil—modified alkyd resin. The dried films contained about 2% lead as both the chromate and the naphthenate. From their data they concluded that approximately 50% of the lead in the naphthenate and 25% of the lead in the chromate migrated from the film under the established experimental conditions.

Another approach toward determining the solubilization of lead from alkyd based paints using simulated gastric and intestinal fluids has been reported by Culp and Rawitch.²⁸ They prepared lead chromate and lead naphthenate formulations to study the ability of the digestive process to physically and chemically break down paint chips and solubilize the lead from the matrix. Their digestive fluids consisted of hydrochloric acid and pepsin (gastric fluid) and a basic simulated intestinal fluid made of ox bile, pancreatin and sodium chloride. Conclusions indicated that less than 1% of the total lead in the lead chromate was solubilized during a two-hr simulated gastric digestion. Data obtained from the intestinal digest phase indicated that the total lead solubilized under

Table 3—Percent Pb Extracted From Total Sample

Hours	Sample #3			Sample #5			Sample #8		
	1	2	Avg.	1	2	Avg.	1	2	Avg.
Gastric	0.012	0.017	0.014	0.002	0.001	0.0015	1.4	1.4	1.4
Intestinal — 3	0.002	0.5*	0.002	0.020	0.067	0.044	0.145	0.153	0.149
Intestinal — 6	0.007	0.003	0.005	0.014	0.002	—	0.162	0.103	0.132
Intestinal — 12	0.012	0.026	0.019	0.046	—	0.046	0.153	0.167	0.160
Intestinal — 24	0.001	0.002	0.0015	0.003	0.002	0.0025	0.333	0.773	—

* Value not included in the average

sequential gastric and intestinal digestion did not exceed 1% of the total lead. Greater amounts of lead were solubilized from the lead naphenate, however no more than 6% of the total lead was solubilized. The data indicated a significant hindering by the alkyl matrix on the solubilization of lead chromate and naphenate.²⁸

Kello and Kostial²⁹ studied the effect of a milk diet on lead metabolism in rats. The body retention of orally applied lead appeared higher in animals fed a milk diet. Their data indicated that milk causes considerable enhancement of lead retention (33-57 times) in the body mainly by greatly increasing its absorption from the intestinal tract.

An investigation by Snowdon and Sanderson³⁰ suggested a real nutritional basis for pica in addition to a lack of parental supervision. Iron deficiency anemia was suggested as a predisposing factor for pica. In addition, there were several metabolic indications of an interaction between lead and calcium. Rats placed on a low calcium diet showed an increased toxicity to lead exposure. Based on their data they concluded that weanling rats do not normally ingest lead when an alternative is available. An imposed calcium deficiency causes a marked elevation in voluntary lead ingestion. This is not totally unique. Rozin and Kalat³¹ suggest that a nutritional deficiency induces the organism to seek other food substances, sampling until one source relieves the aversive symptoms produced by deficiency. Such an animal will continue to ingest the symptom—relieving food unless or until it also produces negative symptoms because of toxicity or nutritional inadequacies of its own.

Lead toxicity has also been studied extensively in the juvenile baboon to determine the degree to which abnormal lead metabolism, side effects and toxicity is representative of the toxic effects of lead poisoning in children.³² It should be pointed out that it is advantageous to use a primate species as an experimental animal. There is also a great similarity between man and the baboon. Their conclusions indicated that the juvenile baboons were susceptible to lead intoxication and that the symptoms and progress of the observed toxicity duplicated those described for childhood lead poisoning.

It may be observed that most experiments are carried out in animals; some human experimentation occurs but is limited to the study of those metals which are not toxic, or in the case of a toxic metal, limited to a study of those individuals who exhibit acute toxicity.

The most commonly used *in vivo* methods are:

(a) Oral ingestion

- (1) concentration of radionuclide in the body is followed and measured.
- (2) concentration of radionuclide in plasma is analyzed.
- (3) concentration of radionuclide in mucosal tissue determined.
- (4) analysis of excreted material.

(b) Injection into the stomach, duodenum or tied off intestinal segments.

The commonly accepted *in vitro* method is the isolation of intestinal segments without a blood supply.

It bears repeating to point out that this is an area still primitive in investigations. Although in recent decades we have accumulated a wealth of knowledge, scientists still are not clear about: (a) the precise locale of trace metals in cells; (b) mechanisms of metal uptake and transfer; (c) physiological mechanisms regulating tissue concentrations; and (d) the interrelationships in an ionic and molecular environment in which elements move.

EXPERIMENTAL

In the preliminary study ground cured paints were used which contained lead octoate (#3), lead chromate (#5) and lead carbonate (#8). An aliquot of simulated gastric fluid was added to each sample, followed by extraction for two hours at 37°C with agitation. The samples were further extracted with simulated digestive fluid. All extracts were analyzed for lead by Atomic Absorption (ASTM Method).

The following simulated fluids were used:

- (a) Gastric fluid — buffered HCl plus pepsin
United States Pharmacopia
Designation
- (b) Digestive fluid — basic buffered solution,
USP Designation pH 7.5, plus pancreatin
- (c) Bile solution — basic buffered solution
plus ox bile

Table 4—Accumulated Data — Extractability Study

Hours		Percent Lead Extracted From Total Sample											
		Sample #3 — Octoate			Sample #5 — Chromate				Sample #8 — Carbonate				
		1	2	Avg.	1	2	3	Avg.	1	2	3	Avg.	
LAB A	Gastric	0.024	0.027	0.027	0.024	0.032	0.025	0.027	1.78	1.25	2.99	2.00	
	Intestinal — 3	0.006	1.19*	0.006	0.214*	0.016	0.40	0.028	2.31	2.21	2.39	2.30	
	Intestinal — 6	—	—	—	0.019	0.059	0.044	0.041	3.81	—	3.58	3.70	
	Intestinal — 12	—	—	—	—	—	—	—	—	—	—	—	
	Intestinal — 24	0.012	0.014	0.013	0.029	0.099	0.048	0.059	10.50	2.02*	13.94	12.22	
LAB B	Gastric	0.0154	0.0167	0.0161	0.0069	0.0059	—	0.0064	1.60	1.66	—	1.63	
	Intestinal — 3	—	—	N.D.	—	—	—	N.D.	0.027	0.035	—	0.031	
	Intestinal — 6	—	—	N.D.	—	—	—	N.D.	0.042	0.037	—	0.040	
	Intestinal — 12	—	—	N.D.	—	—	—	N.D.	0.060	0.071	—	0.066	
	Intestinal — 24	—	—	N.D.	—	—	—	N.D.	0.068	0.103	—	0.086	
LAB C	Gastric	0.012	0.017	0.014	0.002	0.001	—	0.0015	1.4	1.4	—	1.4	
	Intestinal — 3	0.002	0.5*	0.002	0.020	0.067	—	0.044	0.145	0.153	—	0.149	
	Intestinal — 6	0.007	0.003	0.005	0.014	0.002	—	—	0.162	0.103	—	0.132	
	Intestinal — 12	0.012	0.026	0.019	0.046	—	—	0.046	0.153	0.167	—	0.160	
	Intestinal — 24	0.001	0.002	0.0015	0.003	0.002	—	0.0025	0.333	0.773	—	—	

* Value not included in the average

Table 3 indicates the values obtained at our laboratory for percent lead extracted. The intestinal extraction indicated exceedingly poor reproducibility.

Table 4 indicates cumulative data received from three laboratories. Poor reproducibility may again be observed.

Visual observation indicated the filtration step was a primary source of error. Atomic absorption analysis of the filter paper following filtration showed relatively high and variable concentrations of lead on the paper (0.02 — 0.003% Pb). On neutralization of the gastric extracts with intestinal fluid, a noticeable physical change was observed. The lead octoate sample had a heavy flocculant precipitate, the lead carbonate sample a moderate precipitate and the lead chromate sample showed no visual change.

Table 5 indicates the results from a study of pH change versus time. It is likely that hydrolysis of the protein may be occurring thereby causing a pH change in the extracting media. A pH change will affect the behavior of divalent lead in solution. Complex salts may also be forming from the hydrolysis of the metal ion.

PbCl₂ PbCrO₄ forms a colloidal solution and may flocculate

For the lead octoate paint sample a number of other related variables were also observed:

(a) for the gastric extraction, the same percentage of lead was extracted using gastric fluid with and without the enzyme pepsin.

(b) variable speed agitation (10 - 120 cpm) during the extraction process did not affect the percent lead extracted.

(c) finely ground paint chips showed a higher percentage of lead extracted and lead remaining on the filter paper.

A 'Lead Paint Ingestion Study' was undertaken by Midwest Research Institute and sponsored by the National Paint and Coatings Association. Their purpose was to evaluate the toxicity in rats produced by different concentrations of paints containing lead oc-

Table 5—Gastric Fluids — pH vs. Time

	pH	Hours Elapsed
Pure gastric fluid	1.28	1
	1.19	24
	1.17	48
Pure bile	7.58	0
	7.52	24
	7.46	48
Pure intestinal	7.52	0
	7.50	24
	5.15	48
Octoate*	7.74	0
	7.53	2
	6.88	20
	6.40	26
	5.40	46
Chromate*	7.80	0
	7.64	2
	6.01	18
	5.54	24
	5.74	28
	6.03	42
Carbonate*	7.73	0
	5.78	15
	5.92	24
	6.13	28
	6.36	42

* A 2 g paint chip sample treated as per round robin extractability procedure — pH monitored with time change.

toate and lead chromate at varying concentrations compared to an old paint formulation containing white lead.³³ Paint films were supplied by members of the NPCA and the National Bureau of Standards.

Their conclusions indicated that for rats fed older paint formulations containing soluble lead salts (i.e. ~66% lead carbonate) classical lead poisoning was induced and significant increases in blood, kidney, bone, liver and brain lead were observed. The newer paint formulations however, contain insoluble lead pigments and low levels of lead driers. Evidence of toxicity or effect on body burden appeared in rats fed paint containing 12.43% lead chromate. This consisted of an increase in blood lead, without other signs of poisoning. Paint containing 1.95% lead chromate and paint containing 2.05% lead octoate produced no detectable changes in the rats.³³

In December 1974, Consumer Products Safety Commission Chairman Richard Simpson recommended to Congress that 0.5% was a safe level of lead in paint. The recommendation was based on data from a number of lead feeding studies. The literature reflects feeding studies using infant baboons³⁴ as metabolic models for children ingesting lead, in addition to numerous laboratory rat studies.

A petition from the Consumers Union was filed seeking a ban on paints containing more than 0.06% lead. Consumers Union also filed suit in the U. S. District Court asking for a nullification of Simpson's recommendation. Both the petition and the suit are pending.

The National Academy of Sciences ad hoc committee on lead poisoning has concluded that the CPSC studies were not adequate to prove the safety of 0.5% lead in paint. The committee is also in the process of recommending a series of actions they deem necessary to CPSC.

In view of the material presented, which is a reflection of numerous articles consulted, it is my opinion that while physical models are useful for establishing principles, they cannot *at this time* be used to indicate the affinity an organism has for a particular element. Animal models do indeed provide a much closer approximation to human response, but even here the limitations, drawbacks and extrapolation to the human system are limited.

In choosing a model one must keep in mind the goal of the investigation, for the ultimate purpose dictates the parameters which must be known, reproducible and controlled. If one wishes to assess the solubility of material in a given solvent(s)

DR. DARLENE BREZINSKI is Technical Manager of the Instrumental Analysis Group in the Research Services Department of DeSoto, Inc. She received her M.S. and Ph.D. Degrees from Iowa State University in 1967 and 1969, respectively. Prior to joining DeSoto, she served as Assistant Professor and Chairman of the Chemistry Department of Mundelein College, Chicago, Ill.

of defined composition this can be accomplished analytically with relative ease at defined conditions of temperature, pressure, concentration and so forth. However, if one wishes to assess the bioavailability of a material then the method assumes a new perspective, for to assess the bioavailability in a chemical laboratory fashion would be to construct the living organism, its cellular components and selective reactions, some few thousand of which occur in a single living cell. The extraction of a compound or element from a matrix is not necessarily indicative of its bioavailability. In establishing methods from which extrapolation will occur to living systems, it should be borne in mind that usually the metal ion as free ion does not exist in physiological medium, hence to chemically devise a method to measure that concentration is of little value if one's goal is bioavailability.

Nonetheless, to sit back and do nothing could be a grave transgression and one in which ultimate culpability would reflect on the scientific community. However, methods chosen must reflect analytical soundness and span the gap between biochemical reactions in a flask to biochemical reactions in the living organism — from *in vitro* to *in vivo* methods. To do otherwise would be to compromise professional integrity.

SUMMARY

A preliminary investigation into the methods available and currently acceptable for determining the solubility of trace metals (toxic) in the gastrointestinal tract was begun.

Many of the factors which must be considered in attempting to establish a method for determining the solubility of metal ions and metal complexes in the GI tract were considered including the mechanism and physiology of digestion in the GI tract and the chemistry of enzymes. Finally, a brief view was given to some current work in this area, to methodology and the results obtained, and to current controversies. □

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Non-Mercurial Preservatives As Supplements to Mercury In Latex Paint

KANSAS CITY SOCIETY FOR COATINGS TECHNOLOGY
Technical Committee

The previous uncertainty regarding the use of mercurials in coatings prompted this committee to conduct tests using non-mercurial preservatives as supplements to a phenylmercurial in a latex PVA paint.

In order to give the study a frame of reference, results were also obtained using the individual non-mercurials singularly. Thus, some comparisons could be made to the committee's 1973 paper. The same testing procedure was used in both studies.

The accumulated data indicate that some non-mercurials work well in combination with this mercurial with little or no side-effects. Others react negatively, leaving the paint unprotected.

In addition, these results, along with those of the earlier study, point out a need for careful investigation when changing to non-mercurials.

KEY WORDS: Phenylmercurial; Non-mercurials; Preservative; Insult test; Bacteria; Inoculation.

INTRODUCTION

For many months, the paint industry had been continuing under the threat of a ban on mercurial preservatives. A multitude of studies had been performed, individually, by preservative suppliers and paint manufacturers, as well as society committees. However, investigations were centered on the direct replacement of mercurials only. We of the Kansas City Technical Committee concluded that a gap had been left by not studying the effects, and side-effects, of non-mercurial preservatives used in combination with a phenylmercurial. It was also decided that each preservative type should be evaluated singularly to relate their effectiveness within this frame of reference.

PROCEDURE

Initially, numerous suppliers were contacted regarding participation in the project. As in the past, six companies readily accepted the assignment.

Twenty-seven unlabeled samples of a latex wall paint were prepared and shipped to each testing laboratory. The cover letter for the samples requested the following procedure as a guideline for evaluation:

(1) Check sterility of samples as received.

(2) Verify efficacy of insult medium using designated "unprotected" sample, increasing insult level if necessary. (Insult mediums of individual labs are listed in the Appendix.)

(3) Inoculate samples weekly for three weeks. Check sterility at 24 hr, 48 hr, 72 hr, and one week after each inoculation.

(4) Report bacterial growth on a scale of 0-4; 0 = no growth, 4 = heavy growth.

Upon completion of testing, the contributing companies reported results, which were compiled using the following numbering system established by the 1973 Kansas City Society Technical Committee:

0 = No growth.

1 = Some periods of light growth, no heavy growth.

2 = Some periods of moderate growth, no heavy growth.

3 = 1-3 periods of heavy growth during the three inoculations.

4 = 4-6 periods of heavy growth during the three inoculations.

5 = Failure after third inoculation.

6 = Failure after second inoculation.

7 = Failure after first inoculation.

Tables 1, 2, and 3 illustrate the relative efficiency in return to sterility of each preservative using the

Presented at the 53rd Annual Meeting of the Federation of Societies for Coatings Technology in Los Angeles, Calif., October 30, 1975.

Table 1—Preservative Performance. Non-Mercurials

Preservative	Use-Level		Company						Total Results
	lb/100 gal	g/liter	A	B	C	D	E	F	
Blank	—	—	7	7	7	7	7	0	35
1	1.80	2.15	7	7	7	7	7		35
2	1.50	1.80	6	3	7	7	7		30
3	1.25	1.50	6	7	7	7	7		34
4	0.75	0.90	7	4	6	7	7		31
5	1.00	1.20	5	6	7	7	7		32
6	1.00	1.20	1	4	7	1	0		13
7	0.90	1.08	6	3	3	3	4		19
8	1.50	1.80	6	7	7	7	7		34
9	0.40	0.48	7	1	1	0	3		12
10	10.00	12.00	7	7	6	7	7		34
11	2.70	3.24	6	7	6	7	7		33

above scale. The right hand column sums the individual scores, thus presenting a composite.

One basic PVA flat latex wall paint formulation was chosen for this series (RCI 4069-49, see Appendix). A PVA formulation was selected based on prior committee work showing more divergent results as compared to acrylic formulations.

Preservative levels in the non-mercurial portion of the study (Table 1) were based on the suppliers' mean recommended usage level. (See Table 4 for preservatives.) This varies from earlier committee work, which was done at equal cost. Therefore, use-levels are different from the 1973 report.

The mercurial used as a control in this study was 21% di (phenyl mercury) dodecyl succinate, 10% mercury. The highest normal recommended level for preservation is 200 ppm (0.02%) mercury as metal based on total formulation weight. A ladder examining the effectiveness of lower levels, starting at 100 ppm (0.01% mercury metal) is shown in Table 2 of results.

In the third test section, Table 3, combinations of the mercurial and the non-mercurial preservatives were used to determine whether their protective properties were supplementary.

Retains of all samples were stored at 120° F, and checked at one month and four months for significant changes in viscosity, pH, white reflectance, and yellowing. Since no additional differences had occurred at the four-month check, Tables 5, 6, and 7 list the original and one-month results.

Although not shown in the tables, it should be noted that three of the six labs reported all samples, even the blank, initially sterile. On the other hand,

company A reported contamination in samples containing preservatives No.1 and No. 4 only. Preservative No. 5 and the blank from Table 1 were contaminated in company E's report. Company F was unable to encourage growth in the blank and, thus, did not complete testing of the series.

SUMMARY

As can be seen by comparing the totaled results of Tables 1 and 2, non-mercurial preservatives No. 6 and No. 9 are protecting the paint samples nearly as well as 0.5 lb per 100 gal of the mercurial in this formulation. Preservative No. 7, although having scored lower, exceeds the remainder of the non-mercurials. These results show significant conflict with the committee's 1973 report⁴ regarding preservatives No. 1 and No. 3, which performed exceptionally well. Preservative No. 6 is the only non-mercurial showing any consistency in protection between the two reports.

The discrepancies noted here, although not investigated further, may be indicative of a greater dependence on paint formulations than previously noted.

By comparing Tables 2 and 3, it is shown that substantial improvement in protection is found in using preservatives No. 7 and No. 9 with the mercurial control. The remaining preservatives show little or no gain, the result reflects nothing but the addition of the mercurial. The results indicate that preservatives No. 8 and No. 10 effectively diminish protection when used in combination with the phenylmercurial. This was indicated prior to test-

Table 2—Preservative Performance. Mercurial Control

Preservative	Use-Level		% Weight Mercury As Metal	Company						Total Results
	lb/100 gal	g/liter		A	B	C	D	E	F	
12	0.10	0.12	0.0008	6	1	4	7	7		25
12	0.25	0.30	0.002	6	0	2	2	7		17
12	0.50	0.60	0.004	5	0	1	0	5		11
12	1.20	1.44	0.01	1	0	0	0	3		4

Table 3—Preservative Performance. Mercurial/Non-Mercurial Combinations

Preservative	Use-Level		Company						Total Results
	lb/ 100 gal	g/liter	A	B	C	D	E	F	
1	0.90	1.08	1	0	3	1	4		9
2	0.75	0.90	6	0	3	0	6		15
3	0.63	0.75	1	0	3	0	6		10
4	0.38	0.45	7	0	1	0	6		14
5	0.50	0.60	6	0	3	0	4		13
6	0.50	0.60	7	0	3	1	4		15
7	0.45	0.54	1	0	0	0	3		4
8	0.75	0.90	6	5	7	7	7		32
9	0.20	0.24	3	0	0	0	3		6
10	5.00	6.00	7	3	7	7	7		31
11	1.35	1.62	6	0	3	0	4		13

(a) Mercurial used at 0.5 lb per 100 gal.

ing, based on the manufacturers' knowledge of adverse effects related to their products when used with a mercurial.

Adverse reactions were also expected because of the detrimental effects of some raw materials upon the non-mercurials.

Viscosities of all samples remained stable in the storage test. White reflectances appear unchanged within experimental error.

The pH measurements dropped severely, possibly contributing to the poorer results experienced by the majority of non-mercurials. This drop in pH does not appear to be a function of the preservatives, but rather related to the formulation.

The yellowing data shows a general shift in color to the yellow side for all samples. This yellowing was clearly visible. From Table 5, preservative No. 2 appears to cause slightly more yellowness than is basic to the formulation, while preservative No. 9 causes slightly less.

CONCLUSIONS

From the data accumulated in this series, it could be concluded that there are some non-mercurial preservatives that supplement the phenylmercurial in protection from contamination without side-effects, while there are also some cases in which protection is seriously impaired.

Several non-mercurial preservatives have also shown that they are effective individually in specific formulations. However, the lack of consistency between reports should warn the paint formulator to investigate preservatives in his formulations before taking their adequacy for granted.

Likewise, the opposite is true. The poor ratings given to some preservatives in these reports does not conclusively prove that they are without merit.

Finally, it has been shown that phenylmercurials can provide the most consistent protection available.

Table 4—Preservatives

Preservative Number	Description
1	<i>Chemical name:</i> 2 [(hydroxymethyl) amine] 2 methyl propanol <i>Toxicology:</i> Oral LD50 1500 mg/kg in rats <i>EPA registration:</i> 5383-17
2	<i>Chemical Name:</i> 1, 1 - (2-butenylene) bis (3, 5, 7 - triaza-1) - azoniadamantane chloride, 90% <i>Toxicology:</i> Oral LD50 3900 mg/kg in rats <i>EPA registration:</i> Not known
3	<i>Chemical name:</i> 1 - (3-chloroallyl) - 3, 5, 7 triaza-1-azoniadamantane chloride, 67.5% <i>Toxicology:</i> Oral LD50 1190 mg/kg in male rats <i>EPA registration:</i> 464-403-AA
4	<i>Chemical name:</i> Benzyl bromo acetate <i>Toxicology:</i> Oral LD50 255 mg/kg in rats <i>EPA registration:</i> 618-73-AA
5	<i>Chemical name:</i> Hexahydro - 1, 3, 5 - triethyl - S - triazine <i>Toxicology:</i> Oral LD50 284 mg/kg in rats <i>EPA registration:</i> 1965-55
6	<i>Chemical name:</i> 1, 2 - benzisothiazolin - 3 - one bis (2 carbonamidophenyl disulfide) <i>Toxicology:</i> Oral LD50 1400 mg/kg in rats <i>EPA registration:</i> 10182-3
7	<i>Chemical Name:</i> Bis (tributyltin) oxide <i>Toxicology:</i> Oral LD50 633 mg/kg in rats <i>EPA registration:</i> 8314-20
8	<i>Chemical name:</i> Potassium N-hydroxymethyl - N - methylthiocarbamate, 32%, sodium 2-mercaptobenzothiazole, 8% <i>Toxicology:</i> Not known <i>EPA registration:</i> 1448-47
9	<i>Chemical name:</i> Zinc pyridinethione and Poly-brominated salicylanilide <i>Toxicology:</i> Oral LD50 1000 mg/kg in mice <i>EPA registration:</i> 1258-889
10	<i>Chemical name:</i> Modified barium metaborate <i>Toxicology:</i> Oral LD50 205 mg/kg in rats <i>EPA registration:</i> 1448-17-AA
11	<i>Chemical name:</i> Alkyl amine hydrochlorides <i>Toxicology:</i> Oral LD50 500 mg/kg in rats <i>EPA registration:</i> 8489-13
12	<i>Chemical name:</i> 21% di (phenyl mercury) dodecenyol succinate, 10% mercury <i>Toxicology:</i> Oral LD50 300 mg/kg in rats <i>EPA registration:</i> Not known

Table 5—Latex Wall Paint Constants. 120° F Storage. Non-Mercurials

Preservative	Use-Level		Viscosity (KU)		pH		White Reflectance ^a		Yellowing ^b	
	lb/100 gal	g/liter	Initial	1 Month	Initial	1 Month	Initial	1 Month	Initial	1 Month
	Blank	—	—	95	96	8.4	7.2	93.3	93.6	+1.5
1	1.80	2.15	89	90	8.8	7.3	93.3	93.6	+1.5	+2.2
2	1.50	1.80	95	90	8.5	7.2	93.3	93.1	+1.6	+2.8
3	1.25	1.50	97	95	8.5	7.0	93.5	93.6	+1.6	+2.3
4	0.75	0.90	95	95	8.4	7.1	93.3	93.6	+1.5	+2.2
5	1.00	1.20	91	93	8.8	7.2	93.5	93.8	+1.6	+2.4
6	1.00	1.20	90	95	8.6	7.0	93.2	93.5	+1.7	+2.5
7	0.90	1.08	92	93	8.4	7.1	93.3	93.8	+1.5	+2.2
8	1.50	1.80	92	93	8.4	7.0	93.2	93.5	+1.5	+2.0
9	0.40	0.48	94	93	8.3	6.9	93.3	93.6	+1.5	+1.9
10	10.00	12.00	108	98	9.1	7.2	93.8	93.6	+1.6	+2.2
11	2.70	3.24	92	92	8.3	7.0	93.3	93.4	+1.6	+2.5

(a) Reflectance readings taken with Gardner Automatic Multipurpose Reflectometer, series No. 13.

(b) Yellowing taken with Hunterlab Model D-25 Color and Color-Difference meter.

Table 6—Latex Wall Paint Constants. 120° F Storage. Mercurial Control

Preservative	Use-Level		Viscosity (KU)		pH		White Reflectance		Yellowing	
	lb/100 gal	g/liter	Initial	1 Month	Initial	1 Month	Initial	1 Month	Initial	1 Month
	12	0.10	0.12	92	90	8.4	7.3	93.5	93.4	+1.6
12	0.25	0.30	93	92	8.4	7.0	93.5	93.3	+1.6	+2.3
12	0.50	0.60	92	94	8.2	7.3	93.5	93.3	+1.8	+2.3
12	1.20	1.44	91	91	8.1	7.4	93.7	93.4	+1.8	+2.2

Table 7—Latex Wall Paint Constants. 120° F Storage. Mercurial/Non-Mercurial Combinations

Preservative	Use-Level		Viscosity (KU)		pH		White Reflectance		Yellowing	
	lb/100 gal	g/liter	Initial	1 Month	Initial	1 Month	Initial	1 Month	Initial	1 Month
	1	0.90	1.08	90	91	8.5	7.2	93.2	93.2	+1.7
2	0.75	0.90	94	96	8.4	7.3	93.3	93.0	+1.7	+2.7
3	0.63	0.75	93	93	8.2	7.3	93.6	93.3	+1.8	+2.5
4	0.38	0.45	93	93	8.3	7.3	93.7	93.1	+1.7	+2.3
5	0.50	0.60	88	83	8.7	7.3	93.8	93.0	+1.7	+2.6
6	0.50	0.60	92	93	8.4	7.2	93.8	93.4	+1.6	+2.4
7	0.45	0.54	91	90	8.5	7.2	93.5	93.4	+1.7	+2.3
8	0.75	0.90	93	93	8.2	7.2	93.6	93.2	+1.5	+2.2
9	0.20	0.24	91	90	8.3	7.2	93.3	93.2	+1.7	+2.3
10	5.00	6.00	95	93	8.9	7.2	93.7	93.6	+1.5	+2.1
11	1.35	1.62	94	95	8.3	7.4	93.5	93.2	+1.7	+2.4

(a) Mercurial used at 0.5 lb per 100 gal.

KANSAS CITY SOCIETY'S TECHNICAL COMMITTEE

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APPENDIX

INSULT MEDIUMS

Company A — Dose rate of 2×10^6 cells/g of paint, using mixture of five paint spoilage bacteria (*P. aeruginosa*, *A. aerogenes*, *B. subtilis*, *B. megaterium*, and *B. licheniformis*).

Company B — 25-g samples were challenged with 0.5 cc of mixed bacterial inoculum identified as:

<i>Pseudomonas aeruginosa</i>	ATCC	10145
<i>Escherichia coli</i>	ATCC	11229
<i>Aerobacter aerogenes</i>	ATCC	13048
<i>Bacillus subtilis</i>	ATCC	6051

Company C — 5 ml of mixed bacterial suspension (*Escherichia coli*, *Proteus sp.*, *Enterobacter aerogenes* and a micro-aerophilic pseudomonad) used in 100-g aliquots of paint.

Company D — Paint samples were inoculated with a 1.0% hydroxyethyl cellulose solution containing *Pseudomonas aeruginosa* (ATCC 10145) and a spore-forming organism.

Company E — 100-g paint samples were inoculated with 1 ml of mixed bacterial culture:

<i>B. subtilis</i>	ATCC	6633
<i>E. coli</i>	ATCC	11775
<i>Enterobacter aerogenes</i>	ATCC	13048
<i>P. aeruginosa</i>	ATCC	10145

Company F — 100-g paint samples were insulted with 1 ml of a 24-hr culture of *P. aeruginosa*.

PAINT FORMULATION

The suggested interior flat wall paint, Reichhold Formulation 4069-49, is as follows:

Ingredients	Pounds	Gallons
Water	332.0	39.84
Thickener (HEC)	5.5	0.48
KTPP	1.0	0.05
Dispersant	9.0	0.93
Surfactant	3.0	0.34
Coalescent	10.0	1.27
Ethylene glycol	35.0	3.76
Defoamer	2.0	0.27
Preservative	—	—
Titanium dioxide	275.0	7.86
Calcium carbonate	75.0	3.32
Aluminum silicate	125.0	5.82
Diatomaceous silica	15.0	0.86
<i>Disperse on a Cowles mixer and add the following, at reduced speed:</i>		
NH ₄ OH	6.0	0.80
Defoamer	2.0	0.27
40-142 wallpol	260.0	28.55
Water	44.0	5.29
	1199.5	99.71
PVC, %	54.2	
Nonvolatile, % wt	53.8	
Nonvolatile, % vol	33.9	

Corrosion Inhibiting Pigments Used in Latex Coatings on Steel

NEW ENGLAND SOCIETY FOR COATINGS TECHNOLOGY
Technical Committee

Three different latex vehicles were formulated with five inhibiting pigments and noninhibiting control. Coatings were applied to cold rolled steel panels and evaluated for flash rusting, salt spray resistance and humidity resistance. Results indicate that test methods did not correlate with each other. Flash rusting results were indeterminate indicating an area for possible future work. The vehicle was the most important choice since several types of pigments could achieve equal corrosion resistance.

KEY WORDS: Corrosion; Pigments; Steel; Latex coatings; Flash rusting; Salt spray; Humidity resistance.

INTRODUCTION

A previous paper presented by the New England Society for Coatings Technology¹ (NESCT) explored corrosion resistance as a function of the latex vehicle. The study demonstrated differences based on composition. The question of how these vehicles act or react with a variety of corrosion-inhibiting pigments becomes a continuation of that study. Also, this paper is one of a series of studies which includes more complex pigmentation, pigment volume concentration, flash rust inhibition, and exterior exposure. Other important factors in corrosion resistance such as formulating technique, extender pigments, dispersants, and other additives are future considerations.

It is the objective of this paper to explore a limited number of latex/corrosion inhibitor relationships in a simple formulation. Latex-types chosen show a wide variation in composition for evaluation purposes, not commercial feasibility. The formulation is designed to minimize variables while exploiting the latex/pigment relationship.

Presented by Richard Dalton at the 53rd Annual Meeting of the Federation of Societies for Coatings Technology in Los Angeles, Calif., October 30, 1975.

EXPERIMENTAL

To keep the study manageable a limited number of vehicles and pigments were selected. From the prior NESCT study,¹ three latex vehicles were chosen to give a variation in polymer types. These are acrylic, PVA, and vinylidene chloride. From the myriad of possible pigments, five more common commercial ones were chosen, and titanium dioxide as a control. These are lead silico chromate, zinc phosphate, calcium borosilicate, calcium zinc molybdate, and strontium chromate.

Each vehicle was formulated (see *Table 1*) using the same additives at a constant pigment volume content. Nonvolatile content varied in some cases to aid handling properties, and compensate for vehicle solids. The formulation contained only the one pigment for corrosion resistance. Pigment dispersion was accomplished by high speed disperser. Due to reactivity one paint gelled and was not included in the study (PVDC/calcium borosilicate).

Paint was applied to cold rolled steel panels using a #50 wire wound rod. The first coat was air dried one week, and a second coat applied. The second coat was air dried four weeks and the panels tested. Flash rusting was determined on the first coat (see *Table 2*).

One set of panels was subjected to standard salt spray testing, and a second set to humidity (100°F/95%RH). Panels were removed from testing at that time where a definitive failure was exhibited. An attempt was made, within limits, to have the same degree of failure on all panels. Hours to failure for each test are listed in *Tables 3* and *4*. Rating was based on rust, corrosion, blistering and erosion.

DISCUSSION

Testing

The results of exposure to nature cannot be duplicated in the laboratory. However, salt spray (FOG) and humidity laboratory tests do give some

Table 1—Paint Formulations

MATERIAL	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Lead Silico Chromate	423.3	→																
Calcium Zinc Molybdate			309.2	→														
Zinc Phosphate					325.5	→												
Calcium Borosilicate								269.6	→									
Strontium Chromate												401.3	→					
Titanium Dioxide																433.6	→	
Dispersant	13.4																	→
Antifoam	2.2																	→
Water	210.6																	→
Thickener	2.2																	→
Ethylene Glycol	22.3																	→
	Disperse on high speed mixer and let down with																	
PVA emulsion	416.8			416.8			416.8			416.8			416.8			416.8		
Acrylic emulsion		483.9			483.9			483.9			483.9			483.9				483.9
PVDC emulsion			475.5			475.5			475.5			475.5			475.5			475.5
Coalescent	22.3																	→
Water	67.1		66.7	67.1		66.7	67.1		66.7	67.1		66.7	67.1		66.7	67.1		67.1
Defoamer	2.2																	→

correlation to specific use areas. Our laboratory results show that salt spray and humidity tests do not correlate between themselves. Strontium chromate gives good salt spray resistance with PVDC but poor humidity resistance. PVA/strontium chromate gives poorer salt spray than humidity resistance but the pigment leaches excessively from the PVA film. Several pigments with equal humidity resistance show various salt spray resistances. Testing should be directed as close to the environmental use as possible.

Flash Rust

During the preparation of the test panels varying degrees of flash rusting, (i.e., rust spots evolving during the film drying process) occurred as shown in Table 5. No proof was found to link this initial rust-

ing directly to corrosion during testing. Corrosion failure due to spreading from these points was not always evident. The PVDC systems exhibited, generally, the poorest resistance to salt spray and humidity, and the greatest amount of flash rusting. However, PVDC/strontium chromate was better than PVA or acrylic in salt spray. A future study adding a flash rust inhibitor may clarify the point.

Vehicles

Salt spray tests show the acrylic vehicle best with five of six pigments, followed by the PVA with four of six, and the PVDC with only one of five. Humidity tests show the acrylic best with six of six pigments, followed by the PVA with four of six, and the PVDC with zero of five. Totalling these figures it ap-

Table 2—Flash Rusting*

Vehicle Pigment	PVDC	Acrylic	PVA
Lead silico chromate	10%	0	1%
Calcium zinc molybdate	10%	0	1%
Zinc phosphate	3%	3%	0
Calcium borosilicate	—	0	0
Strontium chromate	1%	0	1%
Titanium dioxide	3%	0	10%

(a) Evaluated by ASTM D610.

Table 3—Salt Spray — Evaluation Results*

Vehicle Pigment	PVDC	Acrylic	PVA
Lead silico chromate	96	452	452
Calcium zinc molybdate	96	260	260
Zinc phosphate	96	260	260
Calcium borosilicate	—	452	452
Strontium chromate	452	260	260
Titanium dioxide	96	216	96

(a) Hours to failure.

Table 4—Humidity — Evaluation Results^a

Vehicle Pigment	PVDC	Acrylic	PVA
Lead silico chromate	192	1008	1008 ^b
Calcium zinc molybdate	48	1008	1008
Zinc phosphate	333	1008	1008
Calcium borosilicate	—	1008	288
Strontium chromate	528	1008	1008 ^c
Titanium dioxide	192	333	192

(a) Hours to failure.

(b) Also blisters #6 dense.

(c) Pigment leached out of film.

pears the acrylic is best followed closely by the PVA, and distantly by the PVDC. This indicates the primary point of corrosion resistance is in the vehicle.

Pigments

Titanium dioxide was used in this series as a noncorrosion inhibiting pigment to demonstrate the inhibiting pigments do work, and to what extent. Salt spray and humidity test results were rated in order of decreasing inhibition and these results combined using a rank order correlation. This data is presented in Table 5. Lead silico chromate and strontium chromate appear best, closely followed by zinc phosphate and calcium borosilicate in an overall perspective.

Note that these pigments were used alone (without extenders) and at only one loading (35% PVC). Future studies may cover % PVC and extender pigments.

SUMMARY

The relationship between pigment and solvent vehicle has been studied by many people.^{3,4,5} Water base vehicles are now in the limelight. The object of

Table 5—Order of Inhibition^a

Pigment	Salt Spray	Humidity	Overall
Lead silicochromate	6	4	10
Strontium chromate	4	6	10
Zinc phosphate	3	5	8
Calcium borosilicate	6	2	8
Calcium zinc molybdate	3	3	6
Titanium dioxide	1	1	2

(a) 6 = Most inhibitive; 1 = least inhibitive.

this paper is to further investigate the relationship of pigment to water-borne vehicle. Many theories as to why corrosion occurs have been studied and offered.⁶ Galvanic cells of one type or another appear the cause. The approach of this paper is the simple pigment/binder type relationship one might use to start formulating a water-borne corrosion inhibiting paint.

Combining the elements listed above one may conclude that an acrylic vehicle with lead silicochromate or strontium chromate, incorporating a flash rust inhibitor is the best system. However, as the data in the tables illustrates, the vehicle, pigment and test are more specific. Also, formulating as pigment volume content, extenders, additives etc., may enhance a system to meet a specification. Obviously, as vehicle and pigment technology progress, better paints will be formulated. But still, no one single system will satisfy all needs.

ACKNOWLEDGMENTS

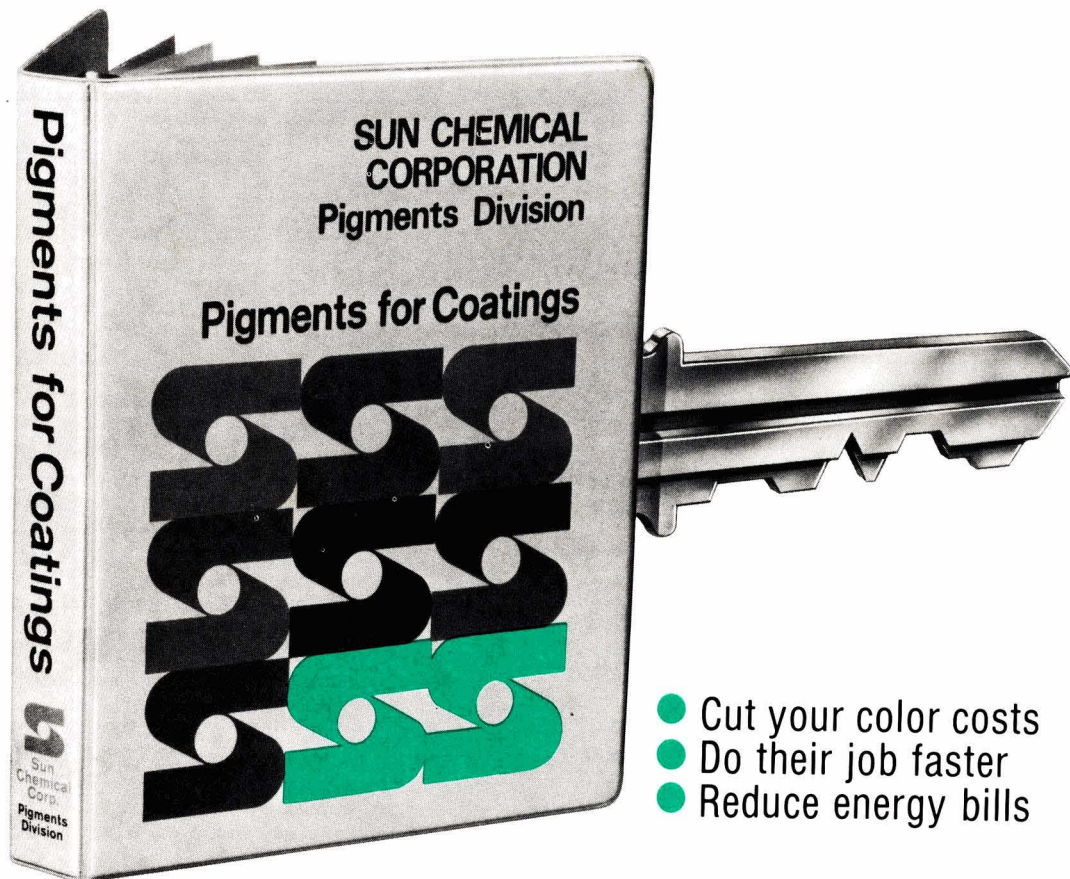
We thank Polyvinyl Chemical Industries, Roy-mal Coating, Inc., Waterlac Industries, and Burgess-Fobes Co. for use of their laboratory facilities. Also we thank the raw material suppliers for their support. □

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January 1976 Subcommittee Reports Of ASTM Committee D-1

The January 1976 Winter Meeting of ASTM Committee D-1 was held on January 14 at the Sheraton Towers Hotel in Orlando, Fla. Approximately 140 members and visitors registered for the 139 meetings of working groups, subcommittees, and the main committee over the three days, January 12-14. Membership in Committee D-1 is now 535.

Bryant Mather, President of ASTM, attended the main, executive, and several subcommittee meetings, and counseled the members on several matters of policy.

Honorary Membership in Committee D-1 was awarded to Kenneth A. Earhart.

A Memorial Resolution was adopted on the passing of Maurice Van Loo, retired, long-term member of D-1.

The Nominating Committee presented the following slate of nominees: Chairman — E. F. Rogers; Vice-Chairman, Administrative — J. C. Weaver; Vice-Chairman, Technical — J. P. McGuigan; Membership Secretary and Treasurer — R. A. Holcombe; Secretary — (open); and Executive Committee Members — H. M. Werner (paint producer), R. R. Bennett (paint component producer), and J. Csernica (user). The nominations were left open for the office of Secretary — there being no definite nominee at the time.

Subcommittee Officer appointments by Chairman Rogers were: Sub. D01.07 on Government Contacts — Leon Birnbaum replacing H. L. Ammlung as Chairman; Sub. D01.15 on Lectures and Symposia — C. M. Winchester as Chairman; and Sub. D01.16 on Definitions — S. LeSota replacing F. Stieg as Chairman.

DIVISION 1 ADMINISTRATIVE

SUBCOMMITTEE D01.06 USACO FOR ISO/TC-35 ON PAINT AND PAINT MATERIALS AND TC-50 ON LAC (SHELLAC)

J. C. Weaver, Chairman

D-1 members H. K. Hammond, III, J. C. Weaver (leader), H. M. Werner, and H. A. Wray attended the September 22-26, 1975 plenary meeting in Zurich of ISO/TC-35 on Paints and Paint Components. TC-35 observed its 25th Anniversary with about 80 in attendance, mainly from West European countries, but also from Russia (2), Iran (1), Canada (1), and the U. S. A. (4). There is a general trend of attention away from components (pigments and drying oils) and over to paint performance tests, under the vigorous U.K. Secretariat for SC-9. There is mounting concern over methodology to serve environmental regulations, but only at the level of drafts before

the European Common Market (ECC) countries collectively, e.g., TC-35/SC-9/WG-U, on "toxic metals" in drafting analytical methods for lead and other metals in components as tentatively proposed in the ECC, rather than in whole liquid or dried coatings as in Canadian and U. S. laws and regulations. The U. S. delegates offered cooperation in selected areas as follows:

- (1) Flash Point and related hazards (Mr. Wray).
- (2) Lead and other metal analysis (Dr. Weaver for R. W. Scott).
- (3) Gloss and other appearances (Mr. Hammond).
- (4) D 3451 Powder Coating Recommended Practices (Dr. Weaver for F. J. Steslow).
- (5) Solvents subsecretariat (Dr. Weaver for T. M. Brye), but to be checked out first with ISO Headquarters and ISO/TC-47.
- (6) Media (polymers and resins) (Dr. Weaver, tentatively), their existing SC-10 with France's AFNOR resigning this secretariat six years after its 1969 inception in Dublin.

We lost to majority vote our strong U.S. preference for the "10—best, 0—worst" subjective rating scales for various kinds of degradation of paint film integrity.

Compared to D-1, TC-35 has a lower proportion of direct industry participation, and is now suffering somewhat from economic depression, but it is accelerating its paint performance activity. Chairman Weaver continues to recommend that it is to D-1's advantage to cooperate through ANSI with ISO/TC-35, but with more attention to drafts and round-robins in TC-35 working groups than to the after-the-fact letter ballots on TC-35's Draft International Standards (DIS's).

Spring of 1977, in the U. S., probably in Philadelphia, is a tentative target for D-1's hosting of the next plenary meeting of TC-35, with Milan, Italy, as the alternate host. In the Spring of 1976, the TC-35 Secretariat and constituent delegates may reach a decision on these choices.

Mr. Wray emphasized the importance of truly international test methods, particularly in flash points and other hazard regulations where

the growth of multi-national companies and the great increase in air travel and commerce have unified needs for methods in common.

Sub. D01.06 secretary, P. G. Campbell, tendered his resignation, and Roy C. Kissler was confirmed as the new secretary.

ASTM paint standards in Parts 27, 28, and 29 are already in wide use in Europe. This subcommittee will begin a more specific program to learn from European sources, both through the eight D-1 members there and via TC-35 members, how to make D-1 Standards more acceptable, as well as more widely used, in Europe.

Listing of ISO/TC-35 vs. D-1 Standards in the 1977 editions of Parts 27, 28, and 29 will be drafted in coming months as an aid to the use of each in North America, Europe, and elsewhere.

SUBCOMMITTEE D01.07 GOVERNMENT CONTACTS

H. L. Ammlung, Chairman

Consideration is being given to transferring the responsibility for Federal Test Method Standard 141 from the Army to the General Services Administration.

Edgewood Arsenal, as the Army Chemical Commodity Center, is considering the adoption of commercial specification for products in Federal Stock Class 6850. This includes a number of documents of interest to D-1, primarily solvents such as acetone.

Concern was expressed about the conversion of Federal Test Methods to ASTM Standards, and vice versa. It was pointed out that the fourth amendment to Federal Test Method Standard has been published and lists all references where ASTM methods have been adopted. Future revisions will be made as ASTM equivalents are prepared and adopted by the interested subcommittees.

H. A. Wray, of Sub. D01.22, discussed the need for greater activity and coordinated effort in dealing with Federal agencies on legislation and regulations in the health and safety area. D01.07 took the matter under advisement for future action.

L. Birnbaum will be assuming the chairmanship of this subcommittee.

SUBCOMMITTEE D01.13 CONSUMER AFFAIRS

E. T. Mooney, Chairman

Chairman Mooney first introduced J. Wilson, of the Kentucky State Purchasing Dept., who was representing the National Institute of

Government Purchasers. Mr. Wilson expressed the need for a better system of buying maintenance paints to be used by state purchasing agents. He said a survey of NIGP members indicated that the purchasing of paint products was their most difficult problem.

Group 1: State and Institutional Paint Consumers, S. B. Levinson, Chairman. The chairman reported that their meeting was an organizational meeting in which the various methods now in use for buying paints were discussed: buying by Federal specifications, state specifications, brand name or equal, and the method based on net weight of active ingredients. R. Brown explained the latter method, indicating that this is now used by the states of Virginia and North Carolina. He said a consulting organization, Intercoastal Piedmont Analytical Corp. (IPAC), will work with states and institutions to train them in this type of paint purchasing, for a fee. Special paint-out charts are furnished. ASTM will mail an explanation of this method to D01.13 members. This document was furnished by J. Wilson of NASPO. Mr. Levinson said his group will hold a meeting before the next D-1 meeting.

E. Mooney stated that the Florida Purchasing Dept. is going to buy paints by use of Federal Specifications. He distributed copies of Florida Spec. 630.45, which lists 12 Federal Paint Specifications that will be used.

Group 2: Individual Paint Consumers, J. Csernica, Chairman. Mr. Csernica reported that the Group feels that the individual paint consumer needs more information and assistance in making a better evaluation of what paint to buy for his specific needs. He would not like to see the Federal government set quality standards for consumer paints.

R. Brown explained the program being conducted by NPCA to educate and assist the individual paint consumer. He discussed the consumer attitude survey conducted by NPCA, and showed the group the Household Paint Selector developed and published by NPCA. He also explained the Glossary of Consumer Paint Terms contained in the booklet. Mr. Brown said that NPCA was in the process of conducting a round-robin to evaluate a group of subjective test methods for reproducibility. Ten paint manufacturers are involved, and the program is being conducted by Litter Laboratories, Inc. Results from this program are expected soon.

Mr. Brown mentioned that some large paint marketers, such as Sears, Roebuck & Co., had published news-

paper ads in the past year in which they attempted to show the buyer the difference in properties of paints carrying different price tags. He felt this was a good effort to help consumers select the right paint for their use.

J. Rothrock, of ASTM, said that D-1 committees have the opportunity to make use of the several Consumer Sounding Boards throughout the country, sponsored by ASTM.

There was some general agreement that: (1) a danger could exist if consumers were led to think in terms of only certain paint properties; (2) some minimum levels of quality are probably needed; and (3) it is better to teach the consumer "how to buy" rather than "what to buy."

SUBCOMMITTEE D01.15 LECTURES AND SYMPOSIA

C. M. Winchester, Chairman

For the 75th Anniversary meeting of ASTM Committee D-1 on January 9-12, 1977, to be held in Philadelphia, Pa., a special commemorative banquet will honor veteran members and their accomplishments, and will also look to the future. Special invitations will be sent to past and present honorary members of D-1. The Philadelphia Society for Coatings Technology will participate as a co-sponsor. J. C. Weaver will highlight past accomplishments of D-1, and W. T. Cavanaugh, Managing Director of ASTM, will project the future of the Society as a whole.

SUBCOMMITTEE D01.16 DEFINITIONS

S. LeSota, Chairman

Definitions of "industrial talc" and "industrial talc, non-asbestos type" have been completed under the chairmanship of F. Stieg (whose 19-year chairmanship was duly recognized).

Sub. D01.25 on Pictorial Standards of Coating Defects has requested definitions for all of the coating defects listed in their proposed Handbook of Pictorial Standards.

Representation by one member of each of the D-1 subcommittees is being solicited—particularly those involved in proposing a new definition.

SUBCOMMITTEE D01.19 PAINT TESTING MANUAL, STP 500 (GARDNER-SWARD HANDBOOK)

J. C. Weaver, Chairman

Edition XIV, to replace Edition XIII of STP 500, the Gardner-Sward Paint Testing Manual, is in active

planning. Of the 46 subsections in Edition XIII, more than a dozen authors have been identified, mainly through chairmen of appropriate subcommittees of D-1. A dozen new subsections are contemplated to relate more completely to the full scopes of all of D-1's technical subcommittees. Volunteers for authorship are invited. Tentative target dates are June 30, 1976 for a full roster of authors, and December 31, 1976 for completion of manuscript for editorial review.

DIVISION 20

RESEARCH AND GENERAL METHODS

SUBCOMMITTEE D01.20 SAMPLING AND STATISTICS

P. G. Campbell, Chairman
R. A. Brown, Acting Chairman

All comments and ballots on the "Recommended Practice for Sampling Pigmented Liquid Paints and Coatings" and the "New Standard Specification for Standard Atmospheres for Conditioning and Testing Paint, Varnish, Lacquer, and Related Materials" were reviewed.

Most comments received on the above Recommended Practice were of an editorial nature and can be accepted. One negative ballot was received. The voter was contacted and, after discussion, it is likely that the negative will be withdrawn after a paragraph or two of explanation is added. The Recommended Practice must then be re-balloted to Sub. D01.20 and D-1.

Several comments were received on the new Standard mentioned above, but no negative votes were received.

Since the chairman and most members were not present, no definite action was taken. Comments, and the recommendation of those present, will be delivered to the chairman for action at the next meeting.

SUBCOMMITTEE D01.21 CHEMICAL ANALYSIS OF PAINTS AND PAINT MATERIALS

R. W. Scott, Chairman

The chairman suggested that since most of the group chairmen will be in Cleveland to attend the Pittsburgh Conference on Analytical Chemistry & Applied Spectroscopy, February

29 thru March 5, 1976, plans were made to meet there on February 29.

Upon the suggestion of H. D. Swafford, the scope of D01.21 will be studied. The chairman asked that suggestions be sent to him.

To obtain more participation in D01.21, solicitation and information on its activities will be sent out to D01.21 members and their management.

It was moved and approved to write a letter of appreciation to J. J. Bennett, who has retired from ASTM and from D01.21.20 on non-volatile content.

Group 3: Metals in Low Concentration, H. D. Swafford, Chairman. The combined method for the "Analysis of Lead and Cadmium in Paints by Atomic Absorption Spectroscopy" received no negatives on the December, 1975 D-1 letter ballot. One comment received pertained to the inclusion of a precautionary statement describing safety procedures on samples containing halogenated polymers, antimony oxide, or nitrocellulose, which will be added as a note in the new draft. The concentration level covered for cadmium will be left at the present 50-150 ppm level, based on paint solids. The combination method is now ready for Society ballot.

A round-robin, conducted during March, 1975, to evaluate a proposed flameless, atomic absorption method for the analysis of low levels of mercury in paints, produced some low and variable results by some collaborators. A new limited round-robin was conducted during November, 1975 with four of the original nine collaborators to re-check their results. Two sets of results have been received to date, both of which show considerable improvement. When all the data are received, a precision statement will be formulated. The method will be submitted for a D01.21 letter ballot with two editorial changes suggested.

A round-robin evaluating a "Proposed Method for the Analysis of Antimony in Paints at Low Levels" was conducted by six collaborators. Three labs have reported their results. Additional analyses will be done by three of the collaborators who have instruments possessing background correction capability to determine the effect of this variable on accuracy, especially for samples containing low concentrations of antimony.

A new round-robin was started to ascertain if improved precision and accuracy could be obtained for a revised version of the "Proposed Method for the Determination of Low Levels of Chromium in Paints." Since only three of the nine labs have reported, a realistic evaluation

of the results is impractical. Several comments received will be incorporated in the fifth draft of the method for future balloting.

Results of a round-robin conducted to determine the applicability of the lead-cadmium method for the analysis of low levels of cobalt in paints were discussed. They appeared satisfactory, but represent only three labs. An expanded round-robin will be conducted in the near future to obtain additional data.

A method which appears to give good results has been developed for determining low levels of copper in paints. However, Group 3 membership felt we should postpone any further evaluation of this method until work has been completed on some other elements of more immediate concern.

The fourth draft of the "Proposed Method for the Detection of Lead in Paint at the 0.5% Level Based on Solids" passed Group 3 letter ballot with 14 affirmatives and 4 abstentions. Comments received, and other minor corrections, will be incorporated into a fifth draft, which will be sent out for D01.21 letter ballot.

J. Devlin has agreed to chair a new section of Group 3, Group 3B, which will evaluate and develop methods for the determination of metals—especially chromium—in air-borne particulates (atmospheric samples of paint and paint materials).

Group 3A: Simulated Gastrointestinal Solubility of Trace Elements, J. T. Vandenberg, Chairman. Data from the latest round-robin study using the "Proposed Method of Determination of Dilute HCL Soluble Lead in Dried Paint Films" were discussed. Five labs participated: three industrial, one government, and one academic.

The study included latex and alkyd-based paints containing 0.5% Pb as the chromate, the naphthenate, and the trimethyl hexanoate. Results obtained indicated fairly good agreement in the amounts of lead recovered from the different systems. A much larger quantity of available lead was recovered from the emulsion paints than from the alkyd-based systems. Some revisions to the method will be made and a new round-robin will be initiated.

Group 4: Chemical Analysis of Whole Paint, J. Hartshorn, Chairman. The chairman called for additional active participants in the group and for new areas in which to work. Powder coatings were suggested and contact will be made with Sub. D01.51 to see if there is a need for our services.

Group 4B: Pigment Content of Emulsion Paints, J. Hartshorn, Chairman. Balloting of the method

"Pigment Content of Emulsion Coatings by Low Temperature Ashing," within Group 4B, received one negative vote, nine affirmative and three abstentions. The negative vote, from H. Ashton, was editorial and will be complied with. The negative has been withdrawn. It was also pointed out that a suitable accuracy statement was missing. If sufficient data to correct this are not available, a new round-robin will be initiated.

Group 4C: Solvent Analysis of Whole Paint, H. Trachman, Chairman. Due to the illness of the chairperson, no activity occurred in this group during the past six months. All actions were deferred to the June meeting.

Group 4D: Analysis of Basic Lead Silico Chromate in Whole Paint, L. DiCarlo, Chairman. Draft two of the proposed method was distributed. An accuracy statement will be prepared and the method will be submitted to D01.21 letter ballot.

Group 4H: Standard Methods of Test for Electrocoat Bath Samples, R. W. Scott, Temporary Chairman. The "Proposed Standard Methods of Test for Characterizing Electrocoat Bath Samples" has been revised and edited based on comments received from members of this task group. Section E, "Co-Solvent Identification," of the original draft has been removed. We will prepare a new procedure, based in part on a publication by Eldrige and Swafford and in part on the original draft, for submission to the task group. This new procedure should cover the GC determination of amine solubilizers and hydroxyl-containing cosolvents.

The revision of the original draft and the first draft of the new procedure will be distributed to interested parties for comment. After this is completed, we will call for round-robin participants to work on the new procedure.

Tentative procedures, or existing procedures, used for the analysis of anionic and cationic systems for components such as SO₂, Cl, nitrates, phosphates, chromates, and trace metals were called for. These procedures may be the basis for further work.

A chairman may soon be appointed for this group.

Group 5: Revision of D 564-47(70), J. Mehaffey, Chairman. This group was reactivated to determine the feasibility of retaining D 564-47(70), "Testing of Liquid Driers." Methods currently described in D 564-47(70) are obsolete. It has been proposed that D 564-47(70) be revised and put in the form of a Recommended Practice to categorize all the methods

needed in D600 specifications. This will be worked on during the next six months.

Group 9: Analysis of Titanium Dioxide, L. H. MacCardle, Chairman. Results of the last round-robin of the tentative procedure for the determination of the anatase/rutile content of TiO₂ indicate the method is workable and acceptable. It will now be submitted to D01.21 for balloting.

The revision of D 1394-63(70), "Chemical Analysis of White Titanium Pigments," was on the D-1 and D01.21 letter ballot of December 12, 1975. To date, the revision has received no negatives. Comments were received from Mr. Ashton, H. Wray, and J. A. deWilde. The comments were related to editorial changes and will be complied with.

A new goal for this group is the establishment of precision and accuracy statements for determining the percent TiO₂ in pigmentary titania. A round-robin will be initiated.

Group 19: Recommended Practice for Determination of Metals, F. Scofield, Chairman. At the previous meeting in Montreal, Canada, a format for the proposed "Recommended Practice for Analyses of Metals in Paint" had been approved. Cooperators have submitted drafts for seven of the metals, with others promised in the very near future. A draft of the proposed Recommended Practice will be circulated to members and will be discussed at the meeting in June.

Group 20: Revision of D 2832-69(74), R. W. Scott, Acting Chairman. The chairman of this group, J. J. Bennett, has retired, but did review the standard and did determine that while the method is cumbersome, it does serve a useful purpose and should be retained as is. The title of the method is "Recommended Practices for Determining Non-Volatile Content of Paint and Paint Materials." This task group will be placed on inactive status.

SUBCOMMITTEE D01.22 HEALTH AND SAFETY

H. A. Wray, Chairman

Group 1: Policy, H. A. Wray, Chairman. In June 1975, the Executive Committee rejected the formation of a group in D01.22 to review new standards for health and safety statements. However, it is still felt that this policing of standards for safety and health statements should be the responsibility of D01.22. (On January 14, the Executive Committee reversed its stand.)

The problem of flammability and flash points of water-reducible coatings was discussed and was referred to Group 16, Flash Points. It was suggested that Sub. D01.07 on Government Contacts form a new group to coordinate analytical methods required by government agencies. This was later rejected by Sub. D01.07.

Group 2: Intercommittee Relationships, W. H. Tuke, Chairman. A letter was written to 12 committees in ASTM outlining the activities of D01.22 and urging their cooperation. Other contacts will be made in the future.

Group 3: Information Resources, D. L. Campbell, Chairman. A mailing was made to D01.22 members requesting additions to the health and safety bibliography. Based on the replies, additions will be made to the bibliography and the entire list will be sent to J. McGuigan for addition to the D-1 Handbook.

Group 16: Flash Point, General, J. L. Abbamondi, Chairman.

(1) Setaflash Methods — Suggestions will be made to Committee D-2 to develop a joint ASTM-IP method for general flash point determination. Extension of D 3278-73, "Test for Flash Point of Liquids by Setaflash Closed Tester," to include viscous materials was discussed. It was agreed that a note be added to the present method describing a means for the addition of material to the cup.

(2) Other Active Methods — D-1, in responding to a request by Committee D-8 on Bituminous and Other Organic Materials for Roofing, etc. to assume jurisdiction of D 1310-72, "Test for Flash Point of Liquids by Tag Open Cup Apparatus," decided to maintain jurisdiction.

It was decided to request Committee D-2 on Petroleum Products and Lubricants to delete the use of water in the space between the sample cup and the stove in the D93 Pensky-Martens tester when used with materials containing suspended solids.

Flash/no flash methods for D56 Tag Closed Cup and D93 Pensky-Martens Tester will be distributed to D01.22 members for comment.

(3) Mixtures — After considerable discussion regarding the testing of flammability of mixtures, especially water-reducible coatings, it was decided to delay any action for the present.

Group 17: Fire Retardancy and Smoke Problems, H. Teicher, Chairman. The new chairman was introduced by H. Wray, who conducted the meeting. P. Liberti will be the

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new vice chairman of Group 17. The two-foot tunnel test will be submitted to D-1 letter ballot.

As a result of the ballot on D 1360-70, "Test for Fire Retardancy of Paints (Cabinet Method)," a negative vote was received. This was considered persuasive, and the method will thus be retained in a revised (to include a leaching test) form.

Group 20: Toxicity, T. W. MacDougal, Chairman. After considerable discussion on a preliminary draft of a Recommended Practice, and questions presented by the chairman, it was decided to revise the scope of the practice to remove references to toxicity. As a result of the discussion, a new draft will be prepared after consultation with other subcommittees of D-1.

Group 24: Potentially Hazardous Effluents, D. L. Campbell, Chairman. Preliminary results of a questionnaire sent to members of D01.22 on possible areas of interest in effluents were discussed. From these results, a number of priority items were indicated. Other ASTM Committees (D-22, E-34, etc.) will be contacted to determine what work has been completed and what is in progress in the field of potentially hazardous effluents.

At the main D01.22 meeting, it was voted that the chairman request that the Executive Committee establish a group within D01.22, or a new subcommittee, to assure that all D-1 standards have adequate and uniform health and safety statements.

Regarding the flammability of water-reducible paints, additional discussion indicated a need for new standards. D01.22, through Group 17, will cooperate with other organizations in establishing adequate standards.

The chairman appointed Mr. MacDougal and Mr. Campbell to act with him as D01.22 representatives to cooperate with Sub. D01.21 to establish adequate D-1/government regulatory agency cooperation.

SUBCOMMITTEE D01.23 PHYSICAL PROPERTIES OF APPLIED PAINT FILMS

M. P. Morse, Chairman

D 3359-74, "Measuring Adhesion by Tape Test," revision has been approved by the subcommittee membership and will be submitted for D-1 letter ballot.

The subcommittee is in the process of revising D 658-44(70), "Test for Abrasion Resistance of Coatings of Paint, Varnish, Lacquer, and Related Products with the Air Blast Abrasion Tester," to incorporate the changes proposed by a recent D-1

negative ballot. Also, suggested editorial changes are being incorporated in D 823-53(70), "Producing Films of Uniform Thickness of Paint, Varnish, Lacquer, and Related Products on Test Panels," D 1186-53(73), "Measurement of Dry Film Thickness of Non-magnetic Organic Coatings Applied on a Magnetic Base," and D 1400-67, "Measurement of Dry Film Thickness of Nonmetallic Coatings of Paint, Varnish, Lacquer, and Related Products Applied on a Non-magnetic Metal Base."

Group 10: Adhesion, H. E. Ashton, Chairman. A round-robin test is being conducted to establish the precision of D 3359-74. Also, a round-robin test is being initiated to investigate the suitability of the Tooke Paint Inspection Gage for measuring adhesion. A questionnaire will be sent to D-1 members to determine what other types of adhesion testers should be investigated.

Group 11: Film Thickness, H. A. Ball, Chairman. A round-robin test has been initiated to determine the precision of the Interchemical and Pfund wet film thickness gages. Also, a round-robin test is being initiated to determine the precision of various types of gages used for measuring the thickness of coatings on a magnetic base.

Group 14: Hardness, Mar Resistance and Abrasion Resistance, E. M. Corcoran, Chairman. A round-robin test is being initiated to determine the precision of the falling sand and the jet abrader tests for abrasion resistance. Floor finishes, marine finishes, coil coatings, and pipe coatings will be used in this test. An effort will be made to develop a mar resistance test for coatings. The first step will be to locate the data obtained from a round-robin test conducted several years ago and use it to determine what test procedures appear worthy of further investigation.

SUBCOMMITTEE D01.24 PHYSICAL PROPERTIES OF LIQUID PAINTS & PAINT MATERIALS

J. F. Hutson, Chairman

The subcommittee letter ballot on a "Standard Method of Test for Viscosity by Dip Type Viscosity Cups" and a "Standard Method of Test for Evaporation Rates of Volatile Liquids" received a 66% vote of the subcommittee membership. There were 33 affirmative (3 no comments), 14 abstaining, and no negatives on the first item, and 30 affirmatives (3 with comments), 17 abstaining, and no negatives on the second item. When editorial comments are incorpo-

rated, the subcommittee will submit these methods to D-1 for committee letter ballot.

Ad Hoc Group on Particle Size Determination — An organizational meeting was held to form a working group to coordinate interest in determination of particle size. Particle size is of interest to Sub. D01.31 on Pigments, Sub. D01.33 on Latexes, and Sub. D01.51 on Powder Coatings, along with Committee E-29 on Particle Size Measurement. This group will welcome any new ideas or interest in this area and is actively seeking a group chairman.

Group 18: Fineness of Dispersion, G. B. Taylor, Chairman. The group reviewed the results of their round-robin on proposed revision of D 1210-64(70), "Test for Fineness of Dispersion of Pigment-Vehicle Systems." Seven cooperators had reported on 16 test performances. The apparent precision was disappointing. There was a feeling that the method, as proposed, had not been adhered to closely enough. An amendment to the method was also adopted. A second round-robin with new paint samples and with two additional cooperators is to be conducted.

Group 19: Viscosity by Efflux Cups, J. F. Hutson, Chairman Pro Tem. The group discussed results of a letter ballot on a "Standard Method of Test for Viscosity Cups" and voted (15-0) to recommend that D01.24 submit this method to D-1 letter ballot.

The group agreed to develop a precision statement for D 1200-70, "Test for Viscosity of Paints, Varnishes and Lacquers by Ford Viscosity Cup," based on a cooperative test with paint materials instead of calibrating oils and, then, to send a recommendation to D01.24 and D-1 for reapproval of this method as revised.

Group 20: Viscosity of Non-Newtonian Materials by Rotational Viscometer, J. F. Hutson, Chairman Pro Tem. The group discussed the precision statement that is to be made for D 562-55(72), "Test for Consistency of Paints Using the Stormer Viscometer," and voted (6-0) to send this precision statement to subcommittee letter ballot. This group agreed to initiate a round-robin using various paints instead of calibrating oils. L. A. DiCorpo will head the task group on the Brookfield Viscometer.

SUBCOMMITTEE D01.25 PICTORIAL STANDARDS OF COATING DEFECTS

S. LeSota, Chairman

This was the first meeting for this subcommittee. The immediate objec-

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tive is to update the Federation's "Exposure Standards Manual" in liaison with the Philadelphia Society for Coatings Technology's Technical Subcommittee on Pictorial Standards. Negatives of half of the Pictorial Standards are available; the status of the other half is the question. We are particularly interested in locating the negative or a good print of the National Coil Coaters' Association's Chalk Standards. Obtaining the remaining photographs will be the joint objective of both D01.25 and the PSCT's subcommittee.

Representation by one member of each of the D-1 subcommittees is being solicited, particularly those involved in proposing a new pictorial standard.

SUBCOMMITTEE D01.26 OPTICAL PROPERTIES

S. J. Huey, Chairman

Group 2: Color Measurement, J. Davidson, Chairman. This group considered how the problem of metameric color matches should be addressed. The group consensus was that existing metamerism indexes were not sufficiently accepted within the color field to merit their being the basis of an ASTM standard. Instead, it was decided that a Recommended Practice be written describing the phenomena, listing those conditions that were amenable to standardization, and suggesting procedures for resolving the problem on an Ad Hoc basis, both within a single organization and between buyer and seller.

Group 11: Gloss and Goniophotometry, R. Kissler, Chairman. Data have been received from collaborators of the D 523-67(72), "Test for Specular Gloss," round-robin test, and these data will be analyzed for the D 523-67(72) precision statement. Certain editorial changes were proposed and will be acted upon. The method will be changed to read that the instrument should be recalibrated if it shows, for a secondary standard, more than ± 1 gloss unit of its assigned value, rather than 1% of its assigned value.

The revision of D 1471-69, "Test for Two-Parameter, 60-Degree Specular Gloss," to include its precision statement will be ready for D01.26 letter ballot.

Group 16: Tinting Strength, P. Mitton, Chairman. It was reported that both D 2745-70, "Test for Instrumental Tinting Strength of White Pigments," and D 332-64(70), "Test for Tinting Strength of White Pigments," have been reapproved.

The possibility of developing an instrumental tinting strength method

for colored pigments was considered, but it was decided to wait for the outcome of some analogous work being done by the Inter-Society Color Council.

Group 17: Hiding Power, P. Mitton, Chairman. It was reported that D 2805-70, "Test for Hiding Power of Paints," has been reapproved. The possibility of developing an ASTM method for hiding power by transmission was discussed, but at this time there was not enough interest.

Group 19: Hemispherical Reflectance, K. Luyk, Chairman. The group reviewed the fourth draft of the method "Test for Total Luminous (Hemispherical) Reflectance of Surfaces by the Integrating Sphere Reflectometer." It incorporated all comments from the D01.26 letter ballot and accommodated the negative ballot from G. Watton.

Group 22: Sample Preparation for the Determination of Optical Properties, K. Hammond, Chairman. It was the consensus of the group present that it was vital to have a recommended procedure to develop good representative samples for gloss and color determination.

A questionnaire is still to be circulated by the chairman concerning current practices.

The resolution of G. Watton's negative ballot for the method on Hemispherical Reflectance was accepted by D01.26 with a unanimous vote. The vote was as follows: Producers—3, Users—2, General Interest—2.

A discussion was held regarding the June, 1975 minutes of Sub. D01.44's Group 3.

Night Visibility of Traffic Paints is a test method which the U. S. General Services Administration has appended to Federal Standard 141, Method 6125 (May 1, 1974), while the 3M Co. has proposed an alternative method which is included in Federal Specification L-S-300b for Reflective Sheeting and Tape. D01.44.03 on Traffic Paint, Night Visibility, at its June 1975 meeting, requested assistance of D01.26 and, at D01.26's option, of Committee E-12 on Appearance, to develop a reflectance method more specific to traffic paints. D01.26 will attempt to form a working and study group from members of D01.26, D01.44, and perhaps E-12.

SUBCOMMITTEE D01.27 ACCELERATED TESTS FOR PROTECTIVE COATINGS

E. A. Praschan, Chairman

Group 2: Water Tests, G. Grossman, Chairman. The round-robin to determine the precision of three existing water test methods (D 870-54-

(73), "Water Immersion Test of Organic Coatings on Steel;" D 1735-62(73), "Water Fog Testing of Organic Coatings;" and D 2247-68(73), "Testing Coated Metal Specimens at 100 Percent Relative Humidity") will proceed as soon as test panels are obtained that give a wider range of performance. Cooperators agreed to contribute panels representing industrial maintenance, coil coating, and automotive finishes (including water-reducible types). The group chairman will screen these test panels for blistering and adhesion prior to distribution to round-robin participants.

Group 4: Light and Water Exposure Apparatus, S. Totty, Chairman. The status of the proposed new "Standard of Testing by the Xenon Arc — Dew Cycle" method will be determined by the chairman. This method, as well as related methods D 822-60(73), "Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products," and D 3361-74, "Recommended Practice for Operating Light- and Water-Exposure Apparatus (Unfiltered Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products Using the Dew Cycle," will be reviewed specifically with regard to reporting details. Since these three methods refer to the use of Method G-23 for operation of equipment, it was suggested that G-23 be included in Volume 27 of the Book of Standards.

Group 10: Outdoor Exposure Tests, M. P. Morse, Chairman. The six months' exposure results on the round-robin test of several coating types, using various outdoor exposure methods, were reviewed. The procedure to be used for evaluating color change is being altered to utilize unexposed reference standards.

Group 16: Chalk Rating, M. Mollman, Chairman. Alternate methods for evaluating chalk on exposed surfaces were discussed. The chairman distributed sets of panels having varying degrees of chalking to several cooperators. Chalking will be rated by several methods currently in use.

Joint Group Sub. D01.27/D01.52: Revision of D 358-70, "Specification for Wood to be Used as Panels in Weathering Tests of Paints and Varnishes." In a joint meeting of these subcommittees, it was agreed to include the density of wood panels at the standard ASTM D-1 condition of $23 \pm 2^\circ\text{C}$, but 60-65% RH approximates more closely the moisture content found in actual outdoor exposure.

These editorial changes, along with other editorial changes concerning conversion to SI units, will be sent to headquarters for inclusion in the next ASTM Book of Standards.

The status of the 29 Standards for which D01.27 is responsible was reviewed. The necessary action on the six methods, which were due for reapproval in 1975, has been completed. Although no Standards are due for reapproval until 1978, there are 11 due at that time. Specific members were assigned to review each of these methods to determine if any revisions are necessary prior to rebalancing. In addition, all subcommittee members will be asked to review these methods and send any comments they may have to the chairman before the June meeting.

M. Mollman, who agreed to act as liaison to Sub. D01.25, reported on the purpose for, and the scope of, that new subcommittee.

Several areas of possible new work were discussed. These included various types of cyclic tests and tests specific to water-reducible coatings. Several members agreed to participate in a round-robin to determine the feasibility of reducing the test cycle time now specified in method D 2246-65(70), "Testing Finishes on Primed Metallic Substrates for Resistance to Humidity-Thermal Cycle Cracking."

SUBCOMMITTEE D01.28 BIODETERIORATION

R. T. Ross, Chairman

Group 1: Package Stability, E. R. Tefft, Chairman. An outline of a revision of D 2574-73, "Test for Resistance of Emulsion Paints in the Container to Attack by Microorganisms," was reviewed. This revision is based upon a number of prior cooperative tests establishing various criteria for the revised method. A cooperative test program, using the revised method, was discussed. Five laboratories will participate. Rust-Oleum Corp. will supply the test paints. Merck & Co. will supply the standard inoculating organisms.

Group 3: Accelerated Tests, R. H. Lalk, Chairman. At the group's last meeting in Montreal, an accelerated test method, generically described as the "Popsicle Stick Test," had been discussed as a possible, simpler alternate to the Environmental Chamber employed in D 3273-73T, "Test for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber." Three laboratories had evaluated the test method. Results obtained were similar in that fungal growth was observed on the uncoated wood, but

none was visible on the unpreserved control paints during the prescribed test period. J. DuPont, of Rohm and Haas Co., who had suggested that Group 3 evaluate the test, was not present, so it was agreed that prior to any additional cooperative tests, Mr. DuPont should be contacted by R. Lalk to determine if previous tests had been conducted correctly.

Another modification of D 3273-73T was discussed by R. Smith, of Abbott Laboratories, Inc. His method employs birch tongue depressors as a substrate for coatings. Approximately one-fourth of the tongue depressor is left uncoated, and this area is inoculated with a mixture of fungal spores. Test specimens are hung vertically in the test cabinet to provide a continuous inoculation of the coating. The advantage reported for this test is a quicker inoculation, although the total test period remains the same as in D 3273-73T.

An effort to modify D 3273-73T so that *Pullularia pullulans* would be the predominant inoculum was reported by S. Mark, of New Jersey Zinc Co. He reported that efforts had been unsuccessful.

The group reviewed final tabulated data for exposure of paints at quarterly intervals in four severe exterior mold test areas. The group agreed that these data provide very useful information as to when and where fungal test exposures can provide results in 8-12 weeks, and that they should be published. The chairman will prepare a draft for review at our next meeting.

The chairman advised the subcommittee that D 3273-73T and D 3274-73T, "Evaluating Degree of Surface Disfigurement of Paint Films by Fungal Growth or Soil and Dirt Accumulation by Photographic Standards," must be submitted by letter ballot for elevation to Standard. It was agreed to do this without modifications.

A new working group, Group 2 on Enzymes, chaired by P. Rosenberg of Rust-Oleum Corp., has been established, and a proposed program of work will be submitted at our June meeting.

DIVISION 30 PAINT MATERIALS

SUBCOMMITTEE D01.31 PIGMENT SPECIFICATIONS

W. C. Spangenberg, Chairman

Session A — The chairman reported that E. Radcliffe had resigned

as chairman of Group 1. K. R. Hancock has agreed to fill this chair. Similarly, for Group 2, K. C. Schumann replaces G. Wormald who has resigned.

The chairman reported that items included on the June, 1975 D01.31 letter ballot will be on a late February, 1976 D-1 ballot. These include:

(1) Proposed Specifications for Anhydrous Aluminum Silicate.

(2) Proposed Specifications for Synthetic Red Iron Oxide, Synthetic Brown Iron Oxide, Natural Red and Brown Iron Oxide, breaking these up into three specifications.

(3) Recommendations of changes of free silica content in D 603-66(73), "Aluminum Silicate Pigments (Hydrous)."

This subcommittee was pleased to receive the following new user members into its membership: T. Accamundo, G. Cunningham, and S. Nowacki. With four reclassifications of members, the committee now has a complete balance with 30 producers and 32 users and general interest.

Session B — A comment, submitted by H. Ashton, on D 1649-65(70), "Specification for Strontium Chromate," suggesting the title for 3.1, Number of Tests, be changed to Sampling, was approved by a vote of 8-0. This is an editorial change.

A comment received from J. A. deWilde on the same specification, regarding the parameters of strontium and chromium content, was referred to Group 1 for a canvas of the industry.

It was decided to limit our June meetings to only two main sessions and have no group meetings. Actions in Groups 1 and 7 are reported above.

By a vote of 8-0, it was agreed to place D 3021-72, "Specification for Phthalocyanine Green," on the next subcommittee ballot for approval as is. This is due for action in 1977.

SUBCOMMITTEE D01.32 DRYING OILS

L. V. Anderson, Chairman

As a result of action taken at the June, 1975 meeting, an opinion poll, dated July 1975, was circulated to members of D01.32. The results of this poll were discussed and the following actions taken:

(1) Fifteen respondents favored the withdrawal of D 1953-70, "Test for Drying Properties of Drying Oils," in favor of the more inclusive write-up D 1640-69(74), "Tests for Drying, Curing or Film Formation of Organic Coatings at Room Temperature," while three respondents favored the retention of D 1953-70. Com-

ments were made pointing out certain modifications to D 1640-69(74) that would be necessary to accomplish the above.

It was moved and carried that Sub. D01.33 be requested to incorporate the necessary modifications in D 1640-69(74)—which is under Sub. D01.33 jurisdiction—probably at the time of their next reapproval action so that the proposal to drop D 1953-70 can eventually be submitted to letter ballot.

(2) Ten people favored the proposal that D 124-70, "Specification for Degummed Soybean Oil," and D 1462-70, "Specification for Refined Soybean Oil," be combined into one specification. Five respondents favored the retention of the two numbers. It was moved and carried that a combined specification be submitted to D01.32 letter ballot prior to the June 1976 meeting.

(3) A request for methods, or ideas leading to a method, for the "Determination of Raw Castor Oil in Coating Systems" drew no positive responses from the subcommittee.

Group 3: Fatty Acid Composition of Oils and Fatty Acids by GLC. O. L. Keplinger, Chairman. In the absence of Dr. Keplinger, no action could be taken. However, a discussion was held and some comments will be forwarded to him.

Group 4: D 1724-63(74), "Determination of Fish Oil in Other Drying Oils," C. L. Schwenk, Chairman. Data were presented on what appears to be a promising method using GC techniques. The details will be written in ASTM format for circulation prior to the June meeting.

Group 5: Revision of D 12-73, "Specification for Raw Tung Oil," R. W. Martin, Chairman. Mr. Martin is in the process of securing additional active participants, both users and traders, to supplement two ASTM volunteers. He expects to have a revision for circulation by the June meeting.

SUBCOMMITTEE D01.33 VARNISH & RESINS, INCLUDING SHELLAC

J. S. Autenrieth, Chairman

Group 12: Urethane Coatings. R. L. Sandridge, Acting Chairman. Two negatives were received in the December 15, 1975 subcommittee letter ballot on a proposed new standard "Method of Test for Free Diisocyanates in Urethane Prepolymers and Coating Solutions by Gas Chromatography." In one, the voter asked to allow the use of a stainless steel

column; the other wanted the title changed to specify toluene diisocyanate only, as in the scope. The group agreed to make the requested changes and to review 10 additional comments on the new method. With the suggested changes, it was moved and carried to submit the method for D-1 letter ballot.

A new method for aliphatic isocyanates by liquid chromatography will be published soon in the literature. Details of this method will be presented for discussion at the next meeting.

D01.33 members voted 10-0 to uphold the two negative votes and to make the requested corrections in the method, as reported above.

Group 14: Alkyd Resins. J. S. Autenrieth, Acting Chairman. The results of the last round-robin on the determination of silicon in silicone-modified alkyds by atomic absorption spectroscopy were reported. The method was tightened up and the results appear to be much better than on the first round-robin. Results from three collaborators have not yet been received. The final results will be circulated, with a precision statement, to members of the group, after which the new method will be submitted to D01.33 letter ballot.

A negative was received in the D-1 letter ballot D01.04 of December 12, 1975 on the reapproval of D 1398-69, "Test for Fatty Acid Content of Alkyd Resins and Resin Solutions." The group agreed with the voter to include a different filtering technique as an alternative in the method. The voter will be contacted for more specific details on his suggested technique.

This group is seeking a new chairman, since W. C. Golton will no longer be active in D-1 work.

D01.33 members voted 10-0 to uphold the negative vote on D 1398-69, and to include the suggested filtering technique as an additional, alternate procedure in the method.

Group 26: Polymer Emulsions. R. R. Brown, Chairman. The results of the last round-robin on a proposed new method for percent nonvolatile of acrylic and vinyl-acrylic emulsions will be submitted to ASTM for computer assistance in preparing a precision statement by the E-180 method. With the precision statement, the new method will be submitted to D01.33 letter ballot.

A round-robin was conducted on a proposed method for the determination of agglomerates in polymer emulsions. The original results were not good. Several changes will be made in the technique and in the apparatus used for the test method, and another round-robin will be

conducted. It is hoped to have the results for the next meeting.

This group is seeking a new chairman, since the present chairman will no longer be active with D-1.

In the D01.04 letter ballot of December 12, 1975, a negative vote was received on the approval of revised D 154-73, "Testing Varnishes." A previous negative by the same voter requested a revision of the section on flash point. Unfortunately, the original wording was included in the ballot instead of the approved new wording. The voter agreed to withdraw his negative vote with the understanding that the correct wording of the flash point section is used. D01.33 members voted 10-0 to uphold the negative vote on D 154-73 and to include the approved wording.

SUBCOMMITTEE D01.35 SOLVENTS, PLASTICIZERS AND CHEMICAL INTERMEDIATES

T. M. Brye, Chairman

Sub. D01.35 offers the following items for the forthcoming D-1 letter ballot:

(1) For adoption as new Standards: Specification for Ethyl Acrylate; Specification for Normal Butyl Acrylate; Specification for 2 Ethyl Hexyl Acrylate; Specification for Amyl Acetate (Synthetic) (98% Grade); Test for Alcohol Content and Purity of Acetate Esters by Gas Chromatography.

(2) For continuation as a Standard without revision: D 343-70, "Specification for Acetate Ester of Ethylene Glycol Monoethyl Ether (95% Grade)."

Sub. D01.35 will have these items for subcommittee letter ballot:

(1) For withdrawal as a Standard: D 657-66(72), "Specification for Isopropyl Acetate (95% Grade)."

(2) For continuation as a Standard without revision: D 1612-60(72), "Test for Acetone in Methyl Alcohol (Methanol);" D 2378-68(72), "Specification for Formaldehyde;" D 2693-72, "Specification for Ethylene Glycol;" D 2694-72, "Specification for Diethylene Glycol;" D 2695-72, "Specification for Propylene Glycol;" D 2696-72, "Specification for Dipropylene Glycol;" and D 3128-72, "Specification for Ethylene Glycol Monomethyl Ether."

(3) For continuation as a Standard with revision: D 1152-72, "Specification for Methyl Alcohol;" D 3126-72, "Specification for Normal Butyl Acetate (98% Grade);" D 3127-72, "Specification for Ethyl Acetate (99% Grade);" and D 3131-72, "Specification for Isopropyl Acetate (98% Grade)."

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Viscosity of dispersion	Lowest	Highest	Medium
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For adoption as new Standards: Specification for Normal Butyl Acetate (99.5%) Grade Urethane; Specification for Ethyl Acetate — Urethane (99.5%) Grade; Specification for 2 Ethoxyethyl Acetate — Urethane (99%) Grade; Specification for Normal Propyl Alcohol (Propanol); Specification for Methyl Ethyl Ketone — Urethane (99.5%) Grade; and Specification for Glacial Acetic Acid.

H. E. Ashton commented specifically on the scope and precision statement of D 1617-72, "Test for Ester Value of Lacquer Solvents and Thinners," which was item 18 on the D01.04 letter ballot. His recommendations were accepted and corrections will be submitted to headquarters. There were no negative votes. Votes were received as follows: seven producers, one consumer and four general interest.

F. Steslow, Jr. voted negative on the proposal to withdraw D 343-70, "Specification for Acetate Ester of Ethylene Glycol Monoethyl Ether (95% Grade)." His negative was upheld to retain this specification until new ones covering available grades of the product are processed. A unanimous affirmative vote for this action and to retain D 343-70 were from two producers and eight general interest. The Standard will now be resubmitted to D-1 for reapproval.

Group 1: Hydrocarbon Solvents, S. A. Yuhas, Chairman. Work continues on:

(1) Determination of aromatics in mineral spirits.

(2) Revision of D 235-61(73), "Specification for Petroleum Spirits (Mineral Spirits)."

(3) D 364-71, "Specification for Industrial Grade Xylene."

Group 2: Oxygenated Solvents, J. M. Ramey, Chairman. Work continues on:

(1) Specifications and test method for 1-nitropropane and 2-nitropropane.

(2) Precautionary statements for test methods on distillation range and nonvolatile determinations regarding peroxides. Precautionary statement concerning pyridine used in D 1364-64(70), "Test for Water in Volatile Solvents (Fischer Reagent Titration Method)."

(3) Precision of platinum-cobalt color measurements below 20 units.

(4) Substitution of color standard component for uranyl nitrate. Standard is used in the permanganate time test D 1363-67(72), "Test for Permanganate Time of Acetone and Methanol."

(5) Analysis of solvents for low concentrations of water.

(6) Specification for methyl n-amyl ketone, methyl iso-amyl ketone, methyl n-butyl ketone, D 657-66(72), "Specification for Isopropyl Acetate (95% Grade)," D 3126-72, "Specification for Normal Butyl Acetate (98% Grade)," D 3126-72, "Specification for Ethyl Acetate (99% Grade)," and D 2916-70, "Specification for Isophorone."

(7) Development of new flask support board for D 1078-70, "Test for Distillation Range of Volatile Organic Liquids."

Group 3: Chemical Intermediates, G. T. Myers, Chairman. Work continues on:

(1) Analysis of acrylates for methyl hydroquinone.

(2) Specification for acrylic acid.

(3) Specification and test methods for multifunctional acrylates.

(4) D 1152-72, "Specification for Methyl Alcohol (Methanol)."

DIVISION 40 PAINT PRODUCTS APPLIED ON SITE

SUBCOMMITTEE D01.42 ARCHITECTURAL FINISHES

S. B. Levinson, Chairman

Membership figures for this subcommittee are as follows: Producers — 29, Users — 8, and General Interest — 29.

Two Revisions of Standards have been approved by D-1, as follows:

D 2931-70T, "Recommended Practice for Testing Latex Flat Wall Paints."

D 2932-70T, "Recommended Practices for Testing Exterior Solvent-Thinned House and Trim Paints."

Two new Standards have also been approved, as follows:

D 3425-75, "Recommended Practice for Testing Solvent-Thinned Interior Semi-Gloss Wall and Trim Enamels."

D 3450-75, "Test for Washability Properties of Interior Architectural Coatings."

No tentative standards are ready for submission to D-1 letter ballot.

Group 1: Washability and Scrub Resistance, M. S. Abriss, Chairman. One comment on the new Standard D 3450-75 was received too late to enable revision before printing. Inasmuch as it entails a change in temperature, it will be submitted for letter ballot.

D 2486-74a, "Test for Scrub Resis-

tance of Interior Latex Flat Wall Paint," is presently under study to improve its precision. Investigations will include the use of narrower shims, of duplicate shims, and of a new polyester bristle brush which is not sensitive to water, and the effect of wear on the brush. A weight-loss technique will also be investigated.

Group 3: Leveling, C. W. Vander-slice, Chairman. Results of the last round-robin demonstrated that the Leneta Blade gave excellent results with a confidence level of more than 95%. This method will be written in ASTM format and submitted for review.

The results of the brushout round-robin using a standardized brush look very good. However, only one cooperator could evaluate the panels using the Leneta brushout leveling standards because of the limitation of sufficient standards. These will be prepared by Leneta and sent to all cooperators. In the meantime, the method will be prepared in ASTM format. However, all references to using these standards for paint roller leveling should be omitted since the standards are based on brushmarks.

Inasmuch as the new drawdown method appears to be superior to D 2801-69(74), "Test for Leveling Characteristics of Paints by Drawdown Method," based on the NYPC blade, the latter will be retested in a round-robin, using the same paints, and then submitted to letter ballot for withdrawal, if found to be deficient.

Group 5: Exterior Paints, J. R. Ingram, Chairman. The last round-robin, investigating a method of testing adhesion to chalked paint, gave confusing results with poor reproducibility between laboratories. The method will be simplified and the procedure prepared in greater detail for the next round-robin.

Group 6: D 2833-74, "Index of Testing Architectural Paints and Coatings," T. W. MacDougall, Chairman. The latest revision has been reviewed by the Editorial Committee and will be submitted for Sub. D01.42 letter ballot.

Group 8: Film Porosity, R. F. Hall, Chairman. Results of the last round-robin, investigating a method for testing paint film coalescence using the K & N ink, were not submitted by all cooperators. They look promising to date but will have to be rechecked when all results are in.

Group 11: Uniformity of Gloss or Sheen, R. Armstrong, Chairman. Results of the last round-robin were poorer than anticipated. The prob-

lems may be either misinterpretation of instructions or variations in rating in this highly subjective test. Both should be resolved by a meeting of all cooperators at one laboratory, where panels will be prepared and evaluated by all present.

Group 17: Paint Spatter, F. B. Burns, Chairman. The method recommended by the chairman was demonstrated. Essentially, it consists of the use of rollers with relatively high and low spatter to bracket results, a specific method of application, large colored sheets to enable collecting all of the spatter produced, and a method of rating the degree of spatter.

Other, simpler methods, which rate partial spatter, were also discussed. Leneta agreed to supply flat black paper sheets to improve visibility of the spatter produced.

A round-robin will be conducted using high and low spatter latex flats, latex semigloss paints, and solvent-thinned semigloss enamels.

Liaison with Other Committees — The following appointments were made: Sub. D01.13 on Consumer Affairs — J. Csernica; Sub. D01.16 on Definitions — S. B. Levinson; and Sub. D01.25 on Pictorial Standards — Mr. Csernica.

J. Csernica reported on the meeting of Group 2 of Sub. D01.13 (The Individual Paint Consumer) of which he is chairman. One recommendation from the floor was that NPCA might try to cooperate with Consumers Union to take advantage of their annual questionnaire to about 500,000 subscribers.

F. Burns, of E Z Painter, offered ASTM D-1 a standard 3-in. roller some years ago. He now manufactures and is offering a standard 2-in. brush for use by interested task groups. The fibre is polyester, which is far less sensitive to water than nylon.

SUBCOMMITTEE D01.43 COATINGS FOR POWER GENERATING FACILITIES A. H. Roebuck, Chairman

Fail-safe coating of the nuclear energy containment areas of power generating facilities has been the focus of D01.43 since its establishment in 1972. Most of these meetings in diverse locations across the U. S. and Canada were associated with meetings of other organizations responsible for various facets of producing electric power from nuclear energy.

The committee has wide representation cutting across a number of industries. For example, at the last meeting, held the first week of

March 1976, about 60 representatives were present from engineering companies, coatings applicators, industry users, independent laboratories, and inspection agencies. They met in various task groups working for the early completion of a comprehensive Manual for Coating Power Generation Facilities, to be issued by ASTM as a Special Technical Publication (STP), after detailed approval of D01.43. Later, after dealing with the special needs of the nuclear power industry, portions of this manual may be recast and re-submitted to letter balloting as Consensus Standards.

The manual's 14 chapters and associated parts are in various stages of completion, as follows:

Preface: Draft completed.

Introduction: Draft completed.

Chapters:

(1) General Considerations — A draft has been completed.

(2) Design and Project Specification Considerations.

(3) Coating System Selection — Completed and approved.

(4) Quality Assurance — Still being worked on by Task Group.

(5) Inspection. Part A: Inspector Qualification and Certification; and Part B: Inspection Procedures — Completed and approved.

(6) Painters Qualification and Certification — Completed and approved.

(7) Safety and Environmental Control — Completed and approved.

(8) Surface Preparation. Part A: White Metal — Nuclear Grade Blast Cleaning; Part B: Near White — Nuclear Grade Blast Cleaning; and Part C: Surface Preparation for Concrete — Completed and approved.

(9) Verification of Coating Materials — Completed and approved.

(10) Coating Application — Completed and approved.

(11) Coating Repairs for Continuous Coating Operation.

(12) Topcoating of Cured Coatings — Work is starting.

(13) Coating Maintenance in Operating Plants — Work is starting; outline to steering committee.

(14) Surveillance Program for Coating Work in Operating Plants — Work is starting.

Appendix A: Glossary of Terms — Working.

Appendix B: References.

SUBCOMMITTEE D01.44 TRAFFIC PAINT

**D. S. Andres, Chairman
L. S. Sander, Chairman Pro Tem**

A memorial resolution was adopted on the passing of Jack D. Wolfe, Chairman of D01.44.01 on Hot

Melt Markings. D. R. Miller was appointed Chairman of Group 1. Mildred A. Post was accepted as a new member of D01.44.

Copies of suggested editorial changes to D-713 on Conducting Road Service Tests will be forwarded to all committee members. Comments will then be forwarded to Mr. Sander for his comment at the June 1976 meeting.

Comments from H. E. Ashton on D-2205 on Recommended Practices for Testing will be sent to all D01.44 chairmen. Mr. Sander will review recommendations to the committee in June.

Group 1: Hot Melt Traffic Marking, D. R. Miller, Chairman. A proposed specification based on the British Specification for testing thermoplastic road markings was forwarded to four U. S. manufacturers of hot melts for their comments. After review, Mr. Miller will present his recommendations to the committee.

Group 2: Accelerated Testing, R. L. Davidson, Chairman. A report was given on the final attempt to evaluate traffic paint by use of the Taber Abraser method. A mini round-robin was conducted by four laboratories using the same three-minute paint. Results ranged from 28 mg loss to 75 mg loss. There are a number of factors contributing to these poor results, but the main problem seems to be the rubber wheel itself. The committee concluded that this method is not applicable to the evaluation of traffic paint.

A general discussion was held on the results of our former round-robin on bleeding, in an attempt to update D-868, "Evaluating Degree of Bleeding." Large differences were noted between the High-Gloss Standard and the Half-Tone Standard in ASTM Part 27. Since most members are still interested in a bleeding test, continued efforts will be made to develop a better method of evaluation.

Group 3: Night Visibility, K. C. Schumann, Chairman Pro Tem. The objectives of the task group were outlined by Mr. Schumann. With the pending withdrawal of D-1011-52(70), "Test for Night Visibility of Traffic Paints," the subcommittee is still looking for an instrumental method applicable to traffic paints. The instrument should be portable so that laboratory or field tests could be performed.

A test method developed at GSA and a method developed by 3M Co. were sent to E-12 and D01.26 in June, 1975 for their comments. H. Lynn Settle and Norbert L. Johnson were asked to serve as our liaison with these committees. Mr. Johnson re-

ported that action has not taken place, and the chairman will investigate the problem.

Group 5: Consistency, Dry Time, and Stability, E. B. Countryman, Chairman. Round-robins will be conducted on the following test methods for the purpose of evaluating modifications of the Standard Methods of Test: D-1309, "Settling Properties — During Storage (Accelerated);" D-869, "Evaluating Degree of Settling;" and D-711, "Determination of No-Pick-Up Time (Drying)."

Four traffic paints will be made and distributed by Baltimore Paint & Chemical Co. Eight methods (including D-1309) of inducing settling will be evaluated by eight cooperators. Two methods for rating the degree of settling will be evaluated, including D-869. Not enough cooperators have volunteered to run the D-711 round-robin. The chairman will seek more cooperators to participate in this round-robin.

SUBCOMMITTEE D01.45 MARINE COATINGS

J. R. Saroyan, Chairman

Group 2: Shallow Submergence, L. Birnbaum, Chairman. A copy of H. Wray's write-up on the proposed test method was to have been submitted to Chairman Birnbaum. Since the write-up has apparently not been received, J. Saroyan will check with S. Lopata as to whether he has received the copy. If not, Mr. Birnbaum shall approach Mr. Wray for the write-up.

The other matter still open is the obtaining of the historical data on the Miami marine test sites. It is intended that this information be issued with the standard to enhance its usefulness.

Mr. Birnbaum has not received a reply on the antifouling history from Miami Marine Research or Miami Marine Testing Co. He shall again contact both for the information. He had hoped to make some progress during his visit to Miami at the conclusion of the ASTM meeting. He also volunteered to attempt to obtain this information from the U. S. Navy, which had employed one of these test locations. The marine history will provide the non-toxic control of the exposure area. It was also decided to include, in the history, the exact period of exposure of the control panel upon which the proposed specification is based. Mr. Saroyan will attempt to obtain this data.

The concept of dynamic testing of antifouling coatings was discussed. The Van London apparatus, the Maritime Administration, and the Battelle approaches were briefly discussed.

Since little has been done in the area of dynamic testing by D01.45, it was agreed that all recipients of these minutes be asked to forward their information on dynamic test equipment to Chairman Saroyan.

T. Dowd agreed to forward the U. S. Coast Guard report on its work in the area of dynamic testing.

Group 3: Intermittent Exposure, R. Devoluy, Chairman. No report was given due to the absence of the chairman.

Group 4: Atmospheric Testing, S. Lopata, Chairman. Some committee matters were discussed in the absence of the chairman.

J. Saroyan has submitted two sets of four panels each to Miami Research for testing. These panels are coated with different inorganic zinc primers, but with the same topcoats. The panels were scribed. L. Birnbaum, through International Paint Co., submitted unscribed panels.

At the conclusion of our meeting, Mr. Birnbaum will visit the site and check whether the panels were exposed.

It was agreed that a laboratory method for raising algae is desirable. J. Saroyan will check the literature to determine what previous work has been done in this area. Group 5 has been organized, with K. Compton as Chairman, to investigate the laboratory growth of algae for improving antifouling coatings.

SUBCOMMITTEE D01.46 INDUSTRIAL PROTECTIVE PAINTING

D. M. Berger, Chairman

E. W. Horvick, Chairman Pro Tem

Group 2 on Painting Low Alloy Steel was discontinued before the June meeting in Montreal. Therefore, although the January program scheduled a meeting, it was not held. However, the presence of 12 people for such a meeting might indicate that this group should be reactivated.

Group 5: PACE/SSPC, J. Keane, Chairman. The group's scope was discussed. It involves ASTM liaison with the SSPC Project PACE for evaluating durability of alternative coatings developed in response to environmental needs and shortages.

It includes paints with alternative new pigments; exempt vs. non-exempt solvents; water-based coatings; and alternatives to sand blasting.

Features include numerous controls re-exposed periodically; four outdoor environments; accelerated tests, correlated with 25 years of previous exposure; generic designations; only the outstanding proprie-

taries to be identified — with suppliers' approval; and statistical design.

ASTM members are welcome to suggest or submit products or to co-sponsor the work.

Group 6: Highway Painting Problems, L. Stevens, Chairman. The chairman was not present at this meeting. It was suggested that J. O'Leary, of the West Virginia Highway Dept., who was in attendance at the meeting, should become the new chairman of the group, pending approval by his employer.

It was suggested that the Maryland pictorial standards, as used by the highway department of that state, be obtained for review by this subcommittee. Mr. O'Leary will obtain these standards.

Mention was made of the pertinence of the Inspection Manual under consideration in Sub. D01.46 for highway paint work.

OSHA and EPA relevance to environmental and effluents standards was mentioned. The question, "Do we need Standards and Practices criteria?", was posed. Also, do enough practical data exist to develop a guide for recommended procedures? A number of highly pertinent considerations and approaches were stated: F-20's work on barriers; contractors' negotiators' coverage of this area; and the Navy average in this field; wet vs. dry blast; water sampling; and reports on effects of blast particles in streams.

Group 7: Inspection, J. C. Moore, Chairman. A recent letter from D. Berger pertinent to this subject was read. The letter related to the overall plan for the forthcoming Inspector's Training Course to be held in several cities, under the direction of the Institute of Applied Technology, of Washington, D. C., and to the Institute's writing of the Inspector's Manual, which is closely related to an effort which already exists in ASTM. A motion was made by A. Eickoff that the Executive Committee review the proposal for the Inspector's Manual and that examination be made to ascertain if existing ASTM work in this area is adequate. Considerable correspondence on this matter written by D. Berger somewhat clarifies the situation and establishes some ground rules. (See D01.47 for a related need.)

Group 8: Railroad Painting Problems, J. Bennett has resigned as group chairman, since he is retiring. M. Stein will take his place. However, Mr. Stein was not present at this meeting. The substance of the minutes of the June meeting in Montreal were reiterated — namely, the paints covered by two military specifications, and the need for more

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If a final decision permits continued use of mercurials, fine! If not, isn't it nice to know that all the eggs weren't in the same basket?



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durable coatings for railroad use. The need for high-performance coatings was re-emphasized, with particular emphasis on the demands of the types of applications encountered in railroad work, whether it be for rolling stock or stationary facilities.

The linings for tank cars carrying aviation fuels call for special consideration. The same applies to those carrying chemicals where durability and freedom from contamination inducement are special requirements.

An important matter for consideration is the kinds of tests that are needed. It would be helpful in resolving this and other matters if the subcommittee had, in its membership, car builders and those involved in the specifications for the railroad industry.

Group 9: Topcoating Zinc-Rich Primers, D. M. Berger, Chairman. It was explained that most of the cooperative work reports done by a number of voluntary producers were in, but some are still missing, and that it is hoped that the zinc-rich primer committee can meet in Chicago in June, 1976 to finalize the two-year effort. Opinion was expressed that copies of the cooperative reports should have been sent to the subcommittee for perusal as a basis for judging what has been done.

Also, disapproval of the establishment of the level of zinc for zinc-rich primers was expressed, on the basis that it is not the prerogative of this subcommittee to pass judgment on such a matter.

J. Keane briefly reported on the status of the SSPC project on topcoating zinc-rich primers. He reflected that evidence indicates that there is not any one method of finding or establishing compatibility.

J. Saroyan made some remarks on the views of Sub. D01.45, Marine Coatings, on this subject. B. Karten mentioned that any temperature variations are strong considerations.

L. Birnbaum reviewed Navy experience from earlier days when zinc-rich coatings were beginning to be used on crafts, where corrosion and abrasion resistance are prerequisites. In topcoating with silicone alkyls, bleeding—leading to a mottled appearance—was experienced. Approaches were then undertaken successfully to overcome the problem. Standard practice now is to use polyamide-cured epoxy with silicone alkyls.

SUBCOMMITTEE D01.47 HIGH-BUILD COATINGS SYSTEMS

P. R. Guevin, Chairman

The first draft of the "Recommended Practices for Evaluation

of High-Performance Architectural Coatings" was briefly discussed with comments for improvement. The chairman will re-draft, incorporating the constructive suggestions, and re-submit for task force comment prior to submission to the subcommittee.

G. A. Stearns, from Oscar Mayer & Co., was on hand to describe a need to develop recommended practices for preparing surfaces such as concrete, steel, and wood for painting. The subcommittee acknowledged a need to develop such a recommended practice, and will collect suggested practices from the members for discussion at our next meeting.

DIVISION 50 PAINTS FOR FACTORY APPLICATION

SUBCOMMITTEE D01.51 POWDER COATINGS

F. J. Steslow, Chairman

C. Grenko presided due to the absence of Chairman Steslow.

D 3451-75, "Standard Recommended Practices for Testing Polymeric Powders and Powder Coatings," was discussed. The current edition was approved in October 1975, and published in December 1975. The results of the recent D-1 ballot D01.04 were discussed. It is limited to certain areas. There were no negative votes, and comments were confined to grammar, punctuation, spelling, and editorial matters.

SUBCOMMITTEE D01.52 FACTORY-COATED WOOD PRODUCTS

C. M. Winchester, Chairman

Group B: Hardboard, R. C. Marck, Temporary Chairman. The round-robin is underway evaluating accelerated test methods for exterior hardboard siding coated with primer and so-called "five-year finish." Details for analyzing and reporting the test results in time for the June meeting were discussed.

Group 11: Dirt Collection, J. J. Medica, Chairman. Editorial changes suggested by Sub. D01.18 were discussed and a revised draft proposal for a method for measuring dirt collection will be prepared. A third round-robin with colored siding has been organized.

Group 12: Textured Board, R. C. Marck, Chairman. As a first step in

developing test methods for textured surfaces, possible adaptation of D 2486-74a, "Test for Scrub Resistance of Interior Latex Flat Wall Paints," will be studied.

The subcommittee approved the following scope for Group 12: "To develop coordinated test methods for factory-applied coatings on wood products with a raised and/or depressed surface made for decorative effect."

Group 52/55: UV-Cured Coatings, K. G. Hahn, Chairman. The results of the round-robin evaluating a proposed accelerated stability test were reviewed. Revised procedures were discussed to overcome the problem of air inhibition, which will be used in a new round-robin. The chairman will prepare a draft of a recommended practice to define all the parameters involved in describing cure conditions on any piece of equipment.

The subcommittee voted to place Group 2, Film Thickness, on inactive status, since there has been no interest shown at the last three meetings in developing the proposed Method C for D 2691-70, "Test for Microscopical Measurement of Dry Film Thickness of Coatings on Wood Products."

No response has been obtained from two letters to Committee D-7 proposing transfer to their jurisdiction of D 2921-70, "Quantitative Tests for the Presence of Water Repellants and Preservatives in Wood Products." Meanwhile, at the time of the meeting, only 16 of the required 34 ballots had been received of the formal vote by the subcommittee to approve the proposed transfer.

SUBCOMMITTEE D01.53 FACTORY-COATED STRIP METAL

E. A. Stockbower, Chairman

Group 2: Cure, K. Luyk, Acting Chairman. This group reported plans for a new round-robin for the solvent-rub test utilizing four methods and three degrees of cure on panels.

D01.53 is continuing to work on an overall guideline specification for coil coated products in conjunction with NCCA, and D. Hueme will act as liaison between D01.53 and NCCA.

SUBCOMMITTEE D01.55 FACTORY-APPLIED COATINGS FOR PREFORMED PRODUCTS

J. M. Behrle, Chairman

Revision of D 2571-71, "Testing Wood Furniture Lacquers." The recent D01.55 balloting produced 21 ballots: 18 affirmative, 3 abstentions, and no negatives. The revisions of

the method will be submitted to D-1 for letter ballot.

Revision of D 3002-71, "Recommended Practice for Evaluation of Coatings for Plastics." D01.55 balloting produced 21 ballots: 18 affirmative, 3 abstentions, and no negatives. This revision will be submitted to D-1 for letter ballot.

Methods for Reapproval:

D 2091-67(72), "Test for Print Resistance of Lacquers." (Review complete. No recommendation for revision.)

D 2620-68(73), "Test for Light Stability of Clear Coatings." (Review complete. Minor editorial change recommended.)

D 3023-72, "Recommended Practice for Determination of Resistance of Factory-Applied Coatings on Wood Products to Stains and Reagents." (Review complete. No recommendation for revision.)

D 3133-72, "Quantitative Determination of Cellulose Nitrate in Alkyd Lacquers by Infrared Spectrophotometry." (Review incomplete.)

D 2199-68(73), "Method of Measurement of Plasticizer Migration from Vinyl Fabrics to Lacquers." Laboratory work is underway to clarify the undesirable effects which occur when vinyl fabrics come into contact with lacquers. The problem is to differentiate between migration and printing.

A task force consisting of D. C. Gleason and E. A. Praschan will compare the General Motors and Ford electrodeposition methods for "throwing power." If the differences are reconcilable, further committee action is planned.

The joint 52/55 meeting on UV-Cured Coatings met after the D01.55 meeting.

SUBCOMMITTEE D01.56 PRINTING INKS

F. A. Falk, Chairman

Group 1: Viscosity Measurements, W. Rusterholz, Chairman. A brief history of the goals of the subcommittee was given. The need for a calibration led to a limited round-robin using two calibration fluids and three trial inks. The data, which were developed by Graphic Supplies, Lehigh University, and Sun Chemical, will be worked up by the chairman and distributed to the members. One additional calibrator has agreed to join the task force. Preliminary results indicate that the complexity of the subject may require a recommended practice rather than a method to minimize inherent errors in using falling-rod viscometers.

Group 2: Wet and Dry Rub Resistance of Print, R. Kinmouth, Chairman. This group will continue to seek different test procedures for measuring both wet and dry rub resistance, including the modified Gardner In-Line Scrub (Schlapfer), the Proctor and Gamble test (Fite), and the Textile Crockmeter (Kinmouth). In January, D. Parsilk agreed to supply printed paper samples for preliminary testing.

Group 6: Roller-Type Tack Testers, J. P. Raymond, Chairman. Results from the preliminary round-robin (five labs) were reviewed and found to be encouraging. Based on these results, a full round-robin will be conducted, using the same two stable inks which were used in the preliminary round-robin as reference

standards, and then testing four unknown production inks. The chairman will edit the test procedure and send a copy to all concerned. F. Falk and J. M. Fetsko will supply ink samples to participants. Misting will be evaluated only as it affects tack readings and not as a separate test method. The chairman will consolidate results and report at the next meeting.

Liaison with Sub. D01.24, K. C. Schumann. This group has reviewed the use of the Hegman gauge. Photographs of various grinds will be modified to facilitate grind measurements. Photographs will include micron readings.

The use of lead chromate pigments in packaging inks was also mentioned.



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Quednau, P.—“Polyisocyanates Cross-Linking with Acrylic Resins;” 65-69.
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Hagele, W.—“The New Edition of the Regulations for Dangerous Working Materials;” 74-78.

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Copenhagen, Denmark

Vol. 22 No. 1 January 1976

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Postfach 6247, Schiffgraben 43, Germany

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Merz, T.—“On the Application of Plaster Facing with Concrete/Plaster Adhesion Bridges;” 104-110.
Wallhauser, K. H., and Fink, W.—“Preservation of Dispersions and Dispersion Paints;” 108-125.
Zosel, A.—“Methods of the Physics of Plastics for Testing Lacquers;” 125-134.
German Standard Draft DIN 53170: Solvents for Paints and Varnishes; Determination of Evaporation Rate; 142.
German Standard Draft DIN 53172: Solvents for Paints and Varnishes; Determination of Evaporation Residue; 143.
German Standard Draft DIN 53173: Solvents for Paints and Varnishes; Determination of Carbonyl Value; 145.
German Standard Draft DIN 53214: Testing of Paints, Varnishes and Similar Products; Determination of Rheograms and Viscosities by Rotational Viscosimeters; 146.

- “Development of the Paint and Varnish Industry in the OECD States;” 160.
“Fully Automatic Production Plant for Base Paints;” 162.

JOURNAL OF THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

Published by: Technical Association of the Pulp and Paper Industry, 1 Dunwoody Park, Atlanta, Ga. 30341

Vol. 58, No. 9 September 1975

(Partial Contents)

- Athey, Robert D., Jr.—“Polymeric Organic Dispersants for Pigments: Useful Structures and Their Evaluations” (Part I); 66-71.

Vol. 58, No. 10 October 1975

- Athey, Robert D., Jr.—“Polymeric Organic Dispersants for Pigments: Useful Structures and Their Evaluations” (Part II); 55-61.

JOURNAL of the OIL AND COLOUR CHEMISTS' ASSOCIATION

Published by: Oil and Colour Chemists' Association, Priory House, 967 Harrow Road, Wembley, Middlesex, England, HAO 2SF

Vol. 59 No. 2 February 1976

- Dunkley, F. G.—“Quality Control of Painting in the Construction Industry;” 39-51.
Gabriel, S.—“Flow of Epoxy-Based Powder Coating Films in Relation to Reactivity, Rheology, and Wetting;” 52-61.
Hoffman, E., Hill, R. K., and Bamed, J. R.—“Fungus-Resistant Paints for the Humid Tropics;” 62-68.
Appleby, A. J., and Mayne, J. E. O.—“The Relative Protection Afforded by Red Lead Dispersed in Linseed Oil, Tung Oil, Oiticica Oil, and a Long Oil Alkyd Varnish;” 69-71.

PIGMENT & RESIN TECHNOLOGY

Published by: Sawell Publications, Ltd., 127 Stanstead Road, London SE23 1 JE, England

Vol. 5 No. 1 January 1976

- Williamson, L. J.—“Technical Innovation in the Light of Changing Consumer Demands for Pigments;” 3-9, 15.
Anon.—“The Solvent Scene—Some Recent Developments from Solvent Supply Companies;” 10-12.

I & E C PRODUCT RESEARCH AND DEVELOPMENT

Published by: American Chemical Society, 1155 16th Street, N.W., Washington, D. C. 20036

Vol. 15 No. 1 March 1976

(Partial Contents)

- Rehacek, K.—“Pigment-Binder Interaction in Paints;” 75-81.

Society Meetings

Baltimore January 15

William C. Spangenberg, of Halox Pigments Div. of Hammond Lead Products, Inc., discussed corrosion-resistant, nontoxic pigments for solvent- and water-reducible primers and finishes.

Educational Committee Chairman Robert M. Hopkins announced that the Federation has requested the Society to produce a slide/tape program on the adhesion of latex paints to chalky substrates.

C. HERBERT PUND, III, *Secretary*

Birmingham January 8

Brian Sykes, of International Paints, spoke on "SOME ASPECTS OF MARINE PAINTING PRACTICE IN 1975."

Mr. Sykes chose as his topic the effect of the surface roughness of the hull on the economics of the operation of the ship. Between 65-80% of the power developed by a ship is used in overcoming the frictional drag.

The main causes of surface roughness are building techniques such as ripple in the steel plate on rolling and the smoothness of the welds, painting techniques, marine fouling, surface corrosion and repainting techniques. Even when using a good anticorrosive and antifouling system, it was found that the surface roughness increased on repainting. One answer is a paint surface which polishes itself by the action of movement through the water.

Q. How long does it take for fouling to occur?

A. Barnacles can settle within 48 hr, but marine weeds can settle in a matter of minutes.

Q. Would it be better if ships could be painted in a controlled atmosphere?

A. Yes, although the sheer size of a ship presents problems of supervision of the paint application.

Q. Is work being done to paint a ship with low-friction "non-stick" coating?

A. The problem with this type of coating is the need for a special type of primer which results in a fairly high degree of roughness.

Q. No mention has been made of the actual film thickness. Is there a tendency to one or two thick coats?

A. 200-150 microns of anticorrosive coating in two coats give problems.

BRIAN F. GILLIAM, *Publicity Officer*

Birmingham February 5

W. G. Thompson, of Revertex, spoke on the "UTILIZATION OF FINANCIAL RESOURCES," or, "first find the money then one can utilize it."

Although the turnover in the U.K. had increased by nearly 20% over the last few years, the actual volume of paint sold showed a negative growth for non-aqueous paints and only 5% growth for emulsions. This demonstrated inflation. Profits are staying static or decreasing, but static profits are decreasing in real terms. Because sales are not being maintained there is less confidence to invest in the industry, and set against this is the rising cost of machinery.

In order to control the financial resources, said Mr. Thompson, it is necessary as possible into the financial planning stage. Examples were given of how the functions of R & D, Production, Marketing, and Finance could contribute to lowering cost and improving profits.

Q. Would you agree that with the present restrictions on industry, in the long term, most companies cannot survive unless there is a change in government policy?

A. Yes, the current price code is a policy for disaster.

Q. Using inflationary accounting, would many big companies show a loss or lower profits than by conventional methods; and, when adopted will there be lower profits to tax?

A. Yes, this will reduce the taxation liability of the companies so one is left wondering where the tax will come from.

BRIAN F. GILLIAM, *Publicity Officer*

Golden Gate February 17

Ken Probst reported that Lourdes C. Ubaldo, of D. J. Simpson Co., and Franklin R. Davis, of du Pont Co. received Certificates of Completion and copies of letters sent to their employers for successfully completing the Elementary Coatings Technology course at the John Adams Adult Center.

Melvin Okowa, of National Institute for Occupational Safety and Health (NIOSH), gave a talk on "HOW NIOSH RELATES TO THE PAINT INDUSTRY." NIOSH is under the Health, Education, and Welfare Dept. (HEW) of the Federal Government and is strictly mandated to research in occupational health and

environment. NIOSH is ordered to report any toxic materials and is currently interested in MEK peroxide. A slide show was presented to illustrate the air sampling techniques of NIOSH.

Q. What are your priorities for investigating the various industries? How do you decide what industries to tackle first?

A. We do not tackle industries. We tackle substances. Presently we are looking at all substances that are carcinogenic. These have priority.

Q. Does NIOSH recommend breathing apparatus?

A. No. We certify for specific use.

KEN G. PROBST, *Secretary*

Los Angeles February 11

Honored guests in attendance were William Dunn, Federation President, and Neil Estrada, President-Elect of the Federation.

Mr. Dunn reported on the recent Federation meeting and show held in Los Angeles and remarked that it was very successful due, in part, to the excellent work done by the meetings and show committee members. Mr. Estrada reported on the various activities of the Federation.

Felix Liberti, of Union Carbide Corp., spoke on the "DEVELOPMENT OF FIRE RETARDANT COATINGS FOR TRADE SALES AND INDUSTRIAL APPLICATION." He explained the function of various fire retardant ingredients and how they are evaluated. Mr. Liberti presented a series of slides to illustrate how the coatings are tested and where they can be used.

FRED CROAD, *Secretary*

Piedmont January 21

Dr. John Trebellas, of Celanese Chemical Co., spoke on "WATER-BORNE COATINGS."

Dr. Trebellas said reduced pollution and fire hazard were some advantages to water-borne coatings. He also discussed some of the pressures being directed toward conventional coatings, such as OSHA and higher petroleum costs.

JAMES A. MARTZ, *Secretary*

New York February 10

Al Sarnotsky announced the death of Society member and Past-President Bernie Karten.

Tom Ginsberg, Technical Committee Chairman, reported on the presentation and demonstration of the important aspects of the Federation training series of slides and tapes.

Jim White, of the Big "H" Corp., spoke on "HIGH SPEED DISPERSION."

Myron Segal, of Premier Mill Corp., presented a program on sand mills.

Arnold Treff, of Charles Ross and Sons Co., spoke on "PAINT DISPERSIONS ON ROLLER MILLS."

John Rahter, of the Paul O. Abbe Co., spoke on efficiency in ball and pebble mills.

GEORGE J. DIPPOLD, *Secretary*

Rocky Mountain January 12

Ralph Stanzola, of Applied Color Systems, Inc., discussed "COLOR STABILITY IN PAINT MANUFACTURE."

He reviewed the use of instrumentation as well as a quantitative and common sense approach to control in paint manufacturing. Among the important factors are: mixing time, use of standard tint pastes, use of accurate scales and good records, sampling procedure, and flexibility of programming.

CHARLES W. IRVIN,
Publicity Chairman

Western New York February 10

Alex Siegel, of Silberline Mfg. Co., Inc., spoke on "THE USE AND MISUSE OF ALUMINUM PIGMENTS IN SURFACE COATINGS."

Aluminum pigments fall into two classifications: leafing and non-leafing. Although both are made the same way the only difference is the type of lubricant used in the manufacture.

Most coating pigments do not present problems in the coating manufacture. However, aluminum pigments have the unique problem of being metallic flakes, and reactive ones at that. They can react with water, acid, or alkaline systems, and it is this reactive property that causes most of the problems in the formulation and storage of paints containing aluminum.

Mr. Siegel said that preventing moisture contamination is the major problem associated with non-leafing aluminum pigments; however, if dry conditions are observed no problems should occur.

He said that leafing aluminum pigment dispersions require certain precautions. Make certain there is no water present. Also, make certain that the resin is chemically neutral.

PAUL R. GUEVIN, *Secretary*

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Eudwood Gardens, Towson). C. HERBERT PUND, III, Conchemco, Inc., 1401 Severn St., Baltimore, Md. 21230.

BIRMINGHAM (First Thursday—Imperial Hotel). GEORGE H. TENNANT, Carr's Paints Ltd., Alvechurch Rd., Birmingham B31 3PG, England.

CHICAGO (First Monday—meeting sites in various suburban locations). RUDOLPH C. ALBRECHT, Standard T Chemicals, Inc., 10th & Washington Sts., Chicago, Ill. 60616.

C-D-I-C (Second Monday—Sept., Jan., Mar. in Columbus; Oct., Dec., Apr. in Cincinnati; Nov., Feb., May in Dayton). RAY SCHOMAKER, Foy-Johnston, Inc., 1176 Mentor Ave., Cincinnati, Ohio 45212.

CLEVELAND (Third Friday—meeting sites vary). Ms. HELEN SKOWRONSKA, Sherwin-Williams Co., P. O. Box 6027, Cleveland, Ohio 44101.

DALLAS (Thursday following second Tuesday—Vic's Gallery Restaurant). DONALD J. WEBB, Jones-Blair Co., P. O. Box 35286, Dallas, Tex. 75235.

DETROIT (Fourth Tuesday—Rackham Memorial Bldg.). MACKENZIE ENDO, Argo Paint & Chemical Co., 550 S. Edwin, Westland, Mich. 48185.

GOLDEN GATE (Monday before Third Wednesday—varies between Sabella's in San Francisco and His Lordship's Restaurant in Berkeley). KEN G. PROBST, San Jose Regional Vocational Center, 760 Hillsdale Ave., San Jose, Calif. 95123.

HOUSTON (Second Tuesday—Sonny Look's Sir-Loin Inn). GERRY J. GOLDBERG, San Jacinto Paint Co., P. O. Box 14312, Houston, Tex. 77021.

KANSAS CITY (Second Thursday—Fireside Inn). RAY LAWSON, Southwest Grease & Oil Co. (Kansas City), Inc., 1400 S. Harrison, Olathe, Kan. 66061.

LOS ANGELES (Second Wednesday—Home Furnishings Mart). FRED CROAD, Engard Coatings Corp., 15541 Commerce Ln., Huntington Beach, Calif. 92647.

LOUISVILLE (Third Wednesday—Essex House). NICK LANNING, Jelico Chemical Co., 829 S. 26th St., Louisville, Ky. 40211.

MONTREAL (First Wednesday—Bill Wong's Restaurant). J. W. A. MELSBACH, Sico, Inc., 2505 de la Metropole, Longueuil, Que., Canada.

NEW ENGLAND (Third Thursday—Fantasia Restaurant, Cambridge). MARTIN L. DAVIS, Sterling-Clark-Lurton Corp., P. O. Box J, Malden, Mass. 02148.

NEW YORK (Second Tuesday—varies between New York and New Jersey locations). GEORGE J. DIPPOLD, Whittaker, Clark & Daniels, Inc., 1000 Coolidge St., South Plainfield, N. J. 07080.

NORTHWESTERN (Tuesday after first Monday—Jax Cafe). JAMES E. FANSLow, Farwell, Ozmun, Kirk & Co., 1200 Mendelssohn Ave. N., Golden Valley, Minn. 55427.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). WILLIAM SHACKELFORD, Gaco-Western, Inc., P. O. Box 88698, Seattle, Wash. 98188.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, Presidential Apartments). WAYNE N. WOOD, Allentown Paint Mfg. Co., P. O. Box 597, Allentown, Pa. 18105.

PIEDMONT (Third Wednesday—Howard Johnson's, Greensboro, N. C.). JAMES A. MARTZ, The Lilly Co., P. O. Box 1821, High Point, N. C. 27261.

PITTSBURGH (First Monday—Skibo Hall, Carnegie-Mellon University Campus). GASPER CAJKA, Chase Chemical Corp., 3527 Smallman St., Pittsburgh, Pa. 15201.

ROCKY MOUNTAIN (Monday prior to second Wednesday—Gasthaus Ridgeview, Wheatridge, Colo.). JOHN S. BAKER, Johns-Manville Corp., Research and Development Center, Denver, Colo. 80217.

ST. LOUIS (Third Tuesday—Salad Bowl Restaurant). BERNARD M. BRILL, P. D. George Co., 5200 N. Second St., St. Louis, Mo. 63147.

SOUTHERN (Gulf Coast Section—Second Tuesday; Central Florida Section—Thursday after third Monday; Atlanta Section—Third Thursday). A ROY NEAL, Superior Lacquer Co., P. O. Box 849, Toccoa, Ga. 30577.

TORONTO (Second Monday—Town and Country Restaurant). PAUL D. F. COOPER, Chemetron of Canada Ltd., 137 Horner Ave., Toronto M82 4Y1, Ont., Canada.

WESTERN NEW YORK (Second Tuesday—Buffalo Trap and Field Club, Cheektowaga, N. Y.). PAUL R. GUEVIN, JR., Hughson Chemical Co., 2000 W. Grandview Blvd., Erie, Pa. 16512.

Elections

BIRMINGHAM

Associate

RICHARDS, TERRENCE — Synthetic Resins Ltd., Liverpool, England.

C-D-I-C

Active

LOHFF, RUEDIGER R. — Muller Industries, Inc., Cincinnati, Ohio.
WISEMAN, GLENN R. — A. C. Mueller Co., Ray, Ohio.

LOS ANGELES

Associate

BRIERS, J. LEE — ICI United States, Inc., Pasadena, Calif.
DEL CROGNALE, LOUIS J. — ICC Solvent Chemical Co., Long Beach, Calif.
HAMLIN, GARETH W. — Velsicol Chemical Corp., Los Angeles, Calif.

MONTREAL

Active

BERNICKY, GILLES C. — Enelchem Products, Montreal, Que.
BIRKELAND, BJORN — International Paints (Canada) Ltd., Montreal.
MARSHALL, MARK L. — Les Encres BCM Inks Ltd., Chomedey-Laval, Que.
PLANTE, ARMAND — Dural Products Ltd., Dorval, Que.
RYAN, ROBERT J. — Opal Paint Inc., Montreal.
STRECKO, BARTHOLOMEW — Les Encres BCM Inks Ltd., Chomedey-Laval.
WEIGHTMAN, CATHAL A. — Les Encres BCM Inks, Ltd., Chomedey-Laval.

Associate

BELLEFLUR, R. D. — Shell Canada Ltd., Montreal.
BLACK, ROBERT M. — Bate Chemical Co., Ltd., Montreal.
FERRIE, ROBERT G. — Ganbo—DW—International Bronze Powder, Valleyfield, Que.
GALLER, STAN J. — Chemicolour Co., Ltd., Montreal.
GODIN, MAURICE — Harrisons & Crosfield (Canada) Ltd., Montreal.
JENNER, GEORGE S. — Harrisons & Crosfield (Canada) Ltd., Montreal.
LAFONTAINE, ANDRE G. — Canadian Titanium Pigments, Ltd., Montreal.
MCDUGALL, KENNETH — Harrisons & Crosfield (Canada) Ltd., Montreal.
RHEAULT, MARVIN J. — Canadian Titanium Pigments Ltd., Montreal.
ZAPPITELLI, FELICE A. — Shell Canada Ltd., Montreal.

NEW YORK

Active

BURNS, RICHARD J. — Union Carbide Corp., Bound Brook, N. J.

BUTT, ABDUL H. — Chemray Coatings Corp., Middlesex, N. J.
GREENWALD, HOWARD — Landers-Segal Color Co., Inc., Brooklyn, N. Y.
KICKI, EDWARD M. — National Research & Development Labs., Newark, N. J.
KLUGMAN, WERNER — Landers-Segal Color Co., Inc., Brooklyn.
RANEN, SEN — Cellofilm Corp., Wood-Ridge, N. J.
ROBINSON, SYLVESTER C. — National Research & Development Labs., Newark.
SALLESE, VINCENT N. — Faber-Castell Corp., Newark.
SCHMIDT, PETER P. — Cellofilm Corp., Wood-Ridge.
SERKANIC, LAWRENCE J. — Hoboken Paint Co., Inc., Lodi, N. J.
STIEG, FRED B., JR. — Pigmentech Consulting, Jamesburg, N. J.

Associate

MUNSON, LOREN R. — Ciba-Geigy Corp., Ardsley, N. Y.

NORTHWESTERN

Active

HEATH, BRIAN C. — Valspar Corp., Minneapolis, Minn.

Associate

BORENIZER, GEORGE W., III — N L Industries, Titanium Pigment Div., Wayzata, Minn.
CALDWELL, ADA J. — Union Carbide Corp., Chicago, Ill.
DOERING, THEODORE J. — American Hoechst Corp., Elk Grove Village, Ill.
HUGHES, DANIEL W. — Mooney Chemicals Inc., Cleveland, Ohio.
STUREK, FRANK A. — Freeman Chemical Corp., Port Washington, Wis.

Educator and Student

LORD, STEPHEN M. — North Dakota State University, Fargo, N. D.
RICHARDS, BRADLEY M. — North Dakota State University, Fargo.

PACIFIC NORTHWEST

Associate

EDWARDS, EUGENE L. — Great Western Chemical Co., Portland, Ore.
FULTS, RICHARD N. — American Hoechst Corp., Foster City, Calif.

PIEDMONT

Associate

KRISTINIK, DON L. — Monsanto, Atlanta, Ga.

ROCKY MOUNTAIN

Active

MIHLFEITH, C. M. — Western Chemical Coatings, Inc., Salt Lake City, Utah.
ROGERS, TERRY W. — Jourgensen Paint Co., Glenrock, Wyo.

Associate

BROWN, LOUIS "SCOTT" — Nalco Chemical Co., Chaska, Minn.
CASH, DAVID E. — Grefco, Denver, Colo.

SOUTHERN

Active

FERGUSON, F. C., SR. — Southland Paint Co., Inc., Stone Mountain, Ga.
GREGERSEN, MICHAEL G. — Midland Division, Dexter Corp., Birmingham, Ala.
ZEGELBONE, JACK — Tropical Asphalt Products, Hallandale, Fla.

Associate

COLE, ANDREW T. — Johns-Manville Sales Corp., Atlanta, Ga.
NELSON, RONALD R. — Kelco Co., Smyrna, Ga.
OTT, MARSHALL — Crucible Chemical Co., Greenville, S. C.
PALMER, FRED H. — Palmer Supplies Co. of Fla., Miami, Fla.
PALMER, SCOTT C. — Palmer Supplies Co. of Fla., Miami.
WELCH, KENNETH F., JR. — Amsco Div., Union Oil Co. of Calif., Atlanta.

Educator and Student

BURNS, LARRY T. — University of Southern Mississippi, Hattiesburg, Miss.
LEGGETT, THOMAS M. — University of Southern Mississippi, Hattiesburg.
MCDANIEL, LARRY M. — University of Southern Mississippi, Seminary, Miss.
RHODES, MARK D. — University of Southern Mississippi, Hattiesburg.

TORONTO

Active

BALL, WILLIAM J. — Canadian Pittsburgh Industries, Toronto, Ont.
BRYDUN, JAMES F. — Canadian Pittsburgh Industries, Toronto.
CHAPMAN, CHARLES A. — Allcolour Paint & Chemicals Ltd., Oakville, Ont.
CHAPMAN, GEORGE B. — Allcolour Paint & Chemicals Ltd., Oakville.
CHAPMAN, G. ROBERT — Allcolour Paint & Chemicals Ltd., Oakville.
GREY, JAMES — L. S. Loave and Associates Ltd., Sarnia, Ont.
JOHNSTON, H. KIRK — Toncecraft Ltd., Toronto.
KING, DENNIS J. — Ashland Oil Canada Ltd., Mississauga, Ont.
LEFAVE, J. G. — Kingsley & Keith (Canada) Ltd., Toronto.
MITSPOPOULOS, TOM — Ashland Oil Canada Ltd., Mississauga.
NARANCIC, NADA M. — Penfound Varnish Co., Ltd., Toronto.
RYBICKY, JAROSLAV — Reichhold Chemicals Ltd., Weston, Ont.
TUERO, HANK — House of Sturgeons (National) Ltd., Weston.

Associate

ALLISON, WILLIAM J. — Canadian Titanium Pigments Ltd., Willowdale, Ont.

BAKA, HENRY B. — Chemroy Chemicals Ltd., Toronto.

BAKER, MICHAEL J. — Charles Tennant & Company, Ltd., Weston.

BERNARDI, JOSEPH A. — Chemroy Chemicals Ltd., Downsview, Ont.

BIGELOW, JOHN H. — Texaco Canada Ltd., Don Mills, Ont.

BIRD, THOMAS — Canadian Titanium Pigments Ltd., Toronto.

BULLOCK, BRIAN — Shell Canada Limited, Don Mills.

CROOKS, THOMAS A. — Cabot Carbon of Canada Ltd., East Willowdale, Ont.

CURRIE, LORNE G. — Reichhold Chemicals Ltd., Toronto.

DAVIS, LAURENCE J. — St. Lawrence Chemical Co. Ltd., Toronto.

DONNELLY, ROY A. — St. Lawrence Chemical Co., Toronto.

DUNCAN, PAUL E. — Esso Chemical Canada, Solvents Dept., Toronto.

GROOTVELD, FANS — CIBA-GEIGY Canada Ltd., Don Mills.

HALPERN, LOU E. — Harrisons & Crossfield (Canada) Ltd., Toronto.

HOUSE, RONALD A. — Bowers Machine Co. Ltd., Downsview.

HOUSTON, HAROLD J. — DuPont of Canada Ltd., Toronto.

HOUSTON, ROBERT W. — Reed Ltd., Pigments Div., Toronto.

JAMES, RONALD J. — Polyvinyl Chemical Industries Ltd., Montreal, Que.

KEEL, TERENCE J. — Inmont Canada Ltd., Toronto.

KOLLAR, JOHN J. — Charles Tennant & Co. Canada Ltd., Weston.

LAIDLAW, WILLIAM E. — L. V. Lomas Chem. Co., Ltd., Mississauga.

MARSHALL, JOHN C. — Dominion Colour Corp. Ltd., Toronto.

MARTIN, ROBERT G. — Pigment & Chemical Co. Ltd., Toronto.

MCDERMOTT, TERRY T. — Hercules Canada Ltd., Toronto.

MCDOWELL, ROBERT W. — Shell Canada Limited, Don Mills.

MCLEOD, WALLY R. L. — Tioxide of Canada Ltd., Toronto.

MO, THOMAS K. — Enelchem Products, Willowdale.

MORREN, ALBERT — Canadian General Electric, Toronto.

PRINCE, DAVID — Nuodex Canada, Ltd., Toronto.

PROVAN, JAMES M. — Chemetron of Canada, Ltd., Toronto.

PROWTEEN, PAUL B. — Esso Chemical Canada, Solvents Dept., Toronto.

RALLISTER, JOHN G. — Harrisons & Crossfield Canada Ltd., Toronto.

RICHARDSON, JOHN A. — Lomas Chemical Co., Ltd., Mississauga.

RIDEOUT, W. B. — Canbro, Div. of International Bronze, Toronto.

RIVERS, WILLIAM H. — Reichhold Chemicals Ltd., Weston.

SOVREY, DOUGLAS S. — St. Lawrence Chemical Co. (Sales) Ltd., Toronto.

TADMAN, RONALD B. — Shell Canada Ltd., Don Mills.

TAYLOR, STEWART M. — Tioxide of Canada Ltd., Etobicoke, Ont.

TRAIN, GEORGE E. — Esso Chemical Canada, Solvents Dept., Toronto.

WALLACE, WILLIAM C. — Allied Chemical Canada, Ltd., Toronto.

WARD, ROBERT A. — Shell Canada Ltd., Don Mills.

WILLIAMS, FREDERICK W. — Esso Chemical Canada, Solvents Dept., Toronto.

WITTES, JOHN C. — F. E. Dempsey & Sons, Toronto.

People

N L Industries' Titanium Pigment Division in reorganizing its marketing department has named **Sargent Heath, III**, Sales Manager — Field Sales Operations. **W. Fraser Malcolm** was appointed Manager of Marketing Administration. **W. A. Kampfer**, former Director of Technical Services, was named Manager of TiO₂ Products at division headquarters. **Richard I. Ensminger** was named Manager of the Technical Service Laboratory. **Jack A. Goldhammer** was appointed Sales Manager of the Southern Region headquartered in Atlanta; and **Robert D. Brickhouse** was named to the same position in the Lake Central Region headquartered in Cleveland.

Ishihara Corp. (U.S.A.), a subsidiary of Ishihara Sangyo Kaisha, Ltd., has announced the appointment of **Harold M. Brez** as Corporate Vice-President, Marketing and his election to the Board of Directors.

E. I. du Pont de Nemours & Co. has announced the formation of a Plastic Products and Resins Dept. which combines the manufacturing, marketing, and research activities of the Plastics and Film Departments. **William G. Simeral** was named Vice-President and General Manager of the new department with **Ivar A. Lundgaard** and **Robert L. Richards, Jr.** serving as Assistant General Managers. **Richard W. Lowe** was named Vice-President and General Manager in the Elastomer Chemicals Dept.

Richard R. Missar has been elected Vice-President — Corporate Marketing Administration for DeSoto, Inc. He joined DeSoto in 1950 and held management positions in sales, marketing and operations. Prior to his promotion he was Group Vice-President — Chemical Coatings.

William L. Held, Sales Representative for the South East region, has been named by Hilton-Davis Chemical Co. to the same position for the pigments division, North Central region. **Lee W. Foster** was also named as Sales Representative in Southern California for the pigment division of Hilton-Davis.

Dr. John R. Nazy was named Industry Manager, Petroleum Products, Water Soluble Polymers for General Mills. Formerly Technical Director for Polymer Research he was succeeded in that position by **Dr. F. William Tuominen**.



W. A. Kampfer

H. M. Brez

Richard H. Burns has been promoted to Western Regional Manager, Resins, for the Industrial Chemicals and Plastics Div. of American Cyanamid Co.

Joseph Fath has been named Vice-President for Planning and Development at Tenneco Chemicals, Inc.

Borden Chemical's Printing Ink Div. has announced four appointments in management. **Fred Petke** was named Technical Manager for technical and development programs. **Gerald Rohe** was appointed Operations Manager. **Trevor Rhodes** was named Sales Manager, and **Louis Schwartz**, Adm. Manager.

Dr. David D. Taft has been appointed a Vice-President of General Mills Chemicals, Minneapolis, Minn.

Charles F. Ashcroft was named National Accounts Sales Manager for Cabot Corp., Carbon Black Div., Akron, Ohio. He has been with Cabot since 1958.

R. T. O'Boyle, was appointed Product Sales Manager for Designed Latexes, Dow Chemical Co., succeeding **Kenneth J. Kerr**, who was named Product Sales Manager for Dow Epoxy Resins.

Thomas Ayr has been appointed to Manager of Sales Administration for The Voltax Co. **Gerret Peters** and **Thomas J. Holland** were named Technical Sales and Service Representatives for New England.

Richard L. Zanewicz has been named Production Manager for the Celanese Coatings and Specialties Co.'s Louisville plant.

Claude C. O'Brien, Jr. has been appointed Vice-President of Marketing and Distribution for PFD/Penn Color.

Davis Paint Mfrs. has announced the appointment of **Max R. Adam** as Assistant General Manager.

Golden Gate Slates "MANUFACTI '76" for June 14

An all-day conference designed to help solve problems common in the industry will be presented by the Manufacturing Committee of the Golden Gate Society for Coatings Technology on June 14. To be held at Sabella's Restaurant, at Fishermans' Wharf, San Francisco, Calif., the program will feature 10 lectures dealing with a variety of topics relating to the manufacturing area.

Manufacturing Committee Chairman Louie Sanguinetti, of D. J. Simpson Co., has announced paper presentations on the following:

"The Customer Is Sometimes Right" — William H. Ellis, of Chevron Research Co.

"Energy Requirements of Dispersing Equipment" — Dale H. Morehouse, of Morehouse Industries, Inc.

"Update on Regulations Affecting the Industry" — Robert E. Minuciani, of Glidden-Durkee Div. of SCM Corp.

"Importance of Manufacturing to the Marketing Effort" — John T. Measday, of Industrial Mineral Ventures, Inc.

Gordon Research Conference Set for July 26-30

A Gordon Research Conference on "Chemistry and Physics of Coatings and Films" will be held July 26-30 at Kimball Union Academy, Meriden, N. H.

The following topics will be discussed:

(July 26) ADHESION OF COATINGS — THEORY AND PRACTICE.

(July 27) DISPERSION OF PIGMENTS: "Interaction Between Pigments and Vehicles," and "Measurement of Degree of Dispersion."

(July 28) NEW POLYMERS: "Photopolymers," "Water-Dispersible Resins," and "Latexes by Emulsification."

(July 29) FUTURE COATING CHOICES: "Summary — Available Choices," "Solvent Recovery," "Solvent Incineration," and "Solventless Coating Types — Comparisons."

(July 30) MANAGEMENT OF RESEARCH: Panel Discussion. NEW RESEARCH: Short Presentations.

Registration fee of \$160 includes meals and lodging.

Complete details are available from Dr. Alexander M. Cruickshank, Director, Pastore Chemical Laboratory, University of Rhode Island, Kingston, R. I. 02881.

"Correcting Dispersing Problems in Production" — Representative from Tenneco Chemicals, Inc.

"Problems in Purchasing" — William Owen, of Fuller-O'Brien Corp.

"The Art of Industrial Communications" — Tom Donovan, of Tom Donovan & Associates.

"Solving Tinting Problems in Production" — Doug Mogler, of Fuller-O'Brien Corp.

"Color Slides for the Industry's Use" — Presentation by members of the Society's Manufacturing Committee (William R. Duncan, of Am-

pex Corp.; Thomas R. Ferron, of Sherwin-Williams Co.; and Ken G. Probst, of San Jose Regional Vocational School).

"A Woman's View of the Coatings Industry" — Sharon Vadnais, of E. T. Horn Co.

Registration fee for the conference is \$20, which includes lunch and dinner. Reservations should be sent to E. "Bud" Harmon, Borden Chemical Co., 4110 Boyce Road, Fremont, Calif. 94538, with check made payable to Golden Gate Society for Coatings Technology.

Polymer Conference Series to be Held May 3-June 9 at University of Detroit

The Eighth Annual Polymer Conference Series of the College of Engineering, University of Detroit, will be held May 3 through June 9.

Designed for those who have a Bachelor's Degree in Engineering or a Physical Science, programs in the series include: "Fundamentals of Polymerization and Polymerization Characterization" (May 3-7); "Advances in Urethane Science and Technology" (May 10-14); "Advances in Coatings Science and Technology" (May 17-19); "Recent Advances in Combustion and Smoke-Retardance of Polymers" (May 25-27); and "Electrodeposition of Organic Coatings" (June 7-9).

ELECTRODEPOSITION OF ORGANIC COATINGS

This program is a lecture-laboratory course directed by Dr. George Brewer, formerly of Ford Motor Co. and now a consultant on coatings. It will consist of a series of lectures on the theory of electrodeposition and a review of recent advances in the field. Each participant will learn how to carry out and actually produce electrodeposited coatings under a variety of bath conditions and evaluate their performance.

ADVANCES IN COATINGS SCIENCE AND TECHNOLOGY

This program includes the following presentations:

"A Range of High Performance Coatings From Water Systems" — Dr. Richard Roesler, of General Mills Corp.

"High Performance UV-Cured

Coatings From Various Polymers" — William Rowe, of Polychrome Corp.

"Recent Advances in the Rheology of High Solids Coatings" — Dr. Clifford Schoff, of PPG Industries, Inc.

"High Solids Room Temperature-Curable Coatings" — Dr. Thomas Miranda, of Whirlpool Corp., and Technical Editor, *Journal of Coatings Technology*.

"Recent Advances in Urethane Coatings" — Dr. K. C. Frisch, of University of Detroit.

"The Measurement of Latices' Particle Sizes and Effect on Rheology and Coating Properties" — Dr. E. A. Collins, of B. F. Goodrich Chemical Co.

"Polymer Pigment Dispersions as a Technique for Obtaining High Performance Coatings" — Dr. H. L. Jakubauskas, of E. I. du Pont de Nemours & Co., Inc.

"Coatings From Topologically Interpenetrating Polymer Networks" — Dr. K. C. Frisch and Dr. D. Klempner, of University of Detroit.

"Polymer Powder Coating Processes" — M. J. Devine, of Naval Air Development Center.

"Advances in Polypropylene Powder Coatings" — Dr. C. E. Smith, Jr. and C. E. Maag, of Hercules Inc.

"Recent Advances in Electrodeposition of Coatings" — Dr. George Brewer, Consultant.

Registration fee for each of the five-day programs is \$370; for the three-day programs, \$260. Housing arrangements are available for all programs.

For additional information, or to register contact Anna Yang, Secretary, Polymer Conferences, University of Detroit, 4001 W. McNichols Rd., Detroit, Mich. 48221.

Pacific Northwest Annual Symposium Slated for Vancouver, May 6-8

The Bayshore Inn, Vancouver, British Columbia will be the site of the 29th Annual Spring Symposium of the Pacific Northwest Society for Coatings Technology, May 6-8.

The technical sessions will feature the following papers:

"Latex Paint Systems with Emphasis on Rheological Properties, Pigment Interaction and Viscosity Stability" — C. W. Vanderslice, of Hercules, Inc.

"Titanium Oxide in Nonaqueous Systems — A New Color Film Presentation" — V. R. Pedersen, of Titanium of Canada, Ltd.

"Epoxy Vinyl Ester Resins Developed for Low Pollution, Low Energy Curable Coatings" — R. A. Buck, of Dow Chemical of Canada Ltd.

"New Developments in Anti-Corrosive Protection" — Judy Cooley and R. E. Vandoren, of N L Industries, Inc.

"Effect of Free Film Preparation on Physical Properties of Organic Coatings" — H. Ashton, of National Research Council of Canada.

"Ground Limestone Slurry — A New Concept of an Old Product" —

W. N. Laughridge, of Sylacauga Calcium Products.

"Future Prospects for Paint" — Ian McEwen, of Canadian Industries Ltd.

"Formulating Parameters for Water-Based Metal Maintenance Coatings" — A. C. Boyce, of National Starch & Chemical (Canada) Ltd.

"Producing for Profit" — Milton M. Golden, of Major Paint & Varnish Co.

"Role of the Independent Research Groups" — Sid Lauren, of Coatings Research Group, Inc.

Social highlights will be a Scottish Night on May 6 and the banquet on May 8.

Registration fee is \$45 in advance (\$55 on-site), and includes the technical sessions, luncheon, and banquet. Fee for ladies' program is \$20. Scottish night tickets are \$12.50 each.

To register, contact Trevor J. Goddard, 1295 Duchess Ave., West Vancouver, British Columbia, V7T 1H3, Canada.

Checks should be made payable to Pacific Northwest Society for Coatings Technology.

Reactive Coatings to be Topic Of NDSU Symposium in June

The 16th Annual Coatings Symposium sponsored by North Dakota State University will present "Energy Savings Through Reactive Coatings." The program will be held June 2-4 at NDSU, Fargo, N. D.

The symposium will explore such important concepts basic to the development of reactive coatings as kinetics of curing, catalysis, stabilization to photodegradation and toxicology. New developments in the fields of urethane and epoxy systems will be considered.

The following papers are scheduled for presentation:

"Kinetics of Curing and Stability of Reactive Coatings" — Dr. Loren W. Hill, of North Dakota State University.

"Principles of Catalysis for Reactive Coatings" — Dr. S. Peter Pappas, of NDSU.

"Rheological Properties of High Solids Coatings" — Dr. Clifford Schoff, of PPG Industries, Inc.

"Photodegradation and Stabilization of Reactive Coatings" — Dr. Charles S. Schollenberger, of B. F. Goodrich Co.

"Toxicological Considerations in Reactive Systems" — Dr. Henry J. Trochimowicz, of du Pont Haskell Laboratories.

"Reaction Variables of Isocyanate Systems for Coatings Applications" — Dr. Zeno W. Wicks, Jr., of NDSU.

"Oxazolidine-Isocyanate Curing Systems" — Dr. William D. Emmons, of Rohm and Haas Co.

"Multifunctional Acrylates in Heat Convertible, High Solids Coatings" — Eli Levine, of Celanese Chemical Co.

"Mechanism of Reaction and Catalysis of Epoxy Systems" — Dr. Herbert A. Newey, of Newey and Busso Associates.

"New Development in Epoxy Coatings" — Loren Munson, of CIBA-GEIGY Co.

"Oxazoline-Functionality for Future Coatings" — Dr. Bruce P. Thill, of Dow Chemical Co.

"Encapsulated Catalysts for Reactive Coatings" — Dr. William T. Short, of General Motors Research Laboratories.

"Reactive Microgels — Potential New Cross-Linkers" — Dr. U. Seitz, of University of Stuttgart.

The enrollment fee of \$185 includes registration, dormitory room accommodations, June 1-3, and meals June 2-4. For more information, or to register, contact the Polymers and Coatings Dept., North Dakota State University, Fargo, N. D. 58102.

Revised Correspondence Course Offered on Surface Phenomena

The Independent Study division of the University of California Extension announces a newly revised correspondence course on "Surface Phenomena in Physical and Biological Systems" for those in industry concerned with the phenomena of colloid and surface chemistry.

The course is intermediate between general physical chemistry textbooks and specialized treatises on the subject, and is designed for people in industry who desire a broad background in surface phenomena — often somewhat neglected in academic training. The prerequisite is an introductory course in college chemistry, physics, or biology, or equivalent work experience.

Dr. Herbert B. Scher, Research Associate with Stauffer Chemical Co., in Richmond, Calif., is author of the course syllabus and also the instructor. Among the topics covered are: surface tension; adsorption; surfactants; emulsions and dispersions; electric double layer; biological membrane transport; water purification by reverse osmosis; characterization of solid particles; adhesion; catalysis; chromatography; biological macromolecules; synthetic polymers; and rheology.

For further information, or to enroll, contact Independent Study, Dept. SP, University of California Extension, 2223 Fulton St., Berkeley, Calif. 94720.

A/V Course on Job Safety And Health Available from OSHA

What every employee and employer should know about the 1970 Occupational Safety and Health Act is spelled out in a new, one-hour orientation program produced by the Department of Labor's Occupational Safety and Health Administration.

In addition to emphasizing rights and responsibilities, the course covers other aspects of the Act, including OSHA standards, enforcement, citations, penalties, state and special programs, recordkeeping and voluntary compliance.

The narrated course provides both employers and employees with an understanding of the Act and how it affects them. Course material includes an instructor's manual, set of 76 color slides, and two audio cassettes. It is available from the Order Section, National Audiovisual Center, General Services Administration, Washington, D.C. 20409; cost is \$22 per set. Orders should specify Employer-Employee Rights and Responsibilities Under the Occupational Safety and Health Act (Short Version).

Paint Courses at Rolla Attract 140 Students; Fall Schedule Announced

The winter session of the Paint Short Courses held at the University of Missouri at Rolla from January 19 to February 13 attracted 140 students from 25 states and Canada. The courses were directed by Lewis P. Larson.

The course for Painting Contractors, Paint Inspectors, Maintenance Engineers, Specifiers and Architects, held Jan. 19-23, attracted 42 students.

The Introductory Course on the Composition of Paints and Coatings, Jan. 26-30, was attended by 48 students.

The Course for Paint Inspectors and Quality Controllers, Feb. 2-6, attracted 22 students.

The Advanced Chemical Coatings Workshop, Feb. 9-13, was attended by 28 students.

Four Paint and Coatings Short Courses have been planned for September and October:

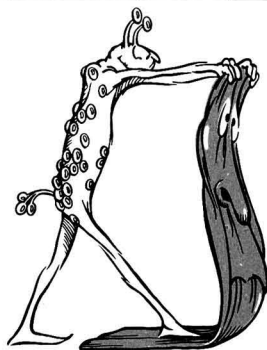
Sept. 13-17 — 24th Short Course for Painting Contractors, Paint Inspectors, Maintenance Engineers, Specifiers and Architects.

Sept. 20-24 — 33rd Introductory Short Course on the Composition of Paints and Coatings.

Sept. 27-Oct. 1 — 5th Short Course for Paint Inspectors and Quality Controllers.

Oct. 4-8 — 27th Advanced Chemical Coatings Workshop.

Fee for each Short Course is \$150. For further information contact Norma Fleming, Coordinator, Extension Div., University of Missouri-Rolla, Rolla, Mo. 65401; or Lewis P. Larson, Box 3073, Columbus, Ohio 43201.



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American Chemical Society To Hold Workshop May 18 On Wiswesser Line Notation

A workshop on "Introduction to the Wiswesser Line Notation: A Practical Approach to Handling Chemical Structure" will be held May 18 at Kent State University just prior to the Central Regional Meeting of the American Chemical Society. The program is being presented by the Chemical Notation Association in cooperation with the Rheology Laboratory of Kent State University's Chemistry Department.

The Wiswesser Line Notation (WLN) is an elegant symbolic language for denoting chemical structure. The workshop will present an introduction to chemical structure representation by graphic, linguistic and numerical techniques. Dr. William J. Wiswesser will introduce WLN and the emphasis for the remaining portion of the program will be on application of this system.

An overview of applications and aids to using the system will be presented to Dr. Norman M. Pollack, of Diamond Shamrock Corp. Dr. Charles Granito, of Chemical Information Management, Inc. will discuss applications of WLN in reference to registration and substructure searching; structure/property correlations and conversion to other representations.

The workshop should be of interest to anyone involved in using the computer to index structures, develop correlations, and list biochemicals, functional groups, mass-spec fragments, X-ray determinations, surfactants, toxic and carcinogenic substances, biochemicals, polymers and chemical inventory, etc.

Complete registration information is available from Carl J. Knauss, Department of Chemistry, Kent State University, Kent, Ohio 44242.

300 Attend Southern Society Annual Meeting

Nearly 300 people attended the 40th annual convention of the Southern Society for Coatings Technology in Atlanta, March 17-19. The Society President-Elect, Thomas E. Marek, of Coronado Paint Co., Edgewater, Fla., served as Program Chairman. The President is Bobby D. Moore, of Interstate Paint Corp., Brunswick, Ga.

Prior to the start of the official program, the Polymer Science Department of the University of Southern Mississippi — in cooperation with the Society — presented a "Symposium on Experimental Design" which attracted an attendance of 18. Lectures were given by Robert H. Brown, of Tennessee Eastman Co.

Technical Program

The two-day technical program consisted of the following presentations:

"U. S. Energy Requirements — Past, Present, and Future"—John H. Wilson, of Union Carbide Corp. (The Keynote Address).

"Recipe for Safety Punch"—Nicholas V. Corda, of Hercules Incorporated.

"Lecithin Development for the Coatings Industry"—Dr. Max Kronstein, of Manhattan College.

Student papers from the University of Southern Mississippi—Presented by Bill Dreher, Mark Rhodes, Larry McDaniel, and Jim Powell.

"Economic and Technical Parameters of Pigment Dispersions"—George Goodwin, of Daniel Products Co.

"Outlook for Titanium Dioxide"—Dr. Roy J. Fahl, of the du Pont Co.

"The Design for Rheological Measurement and Improvement of Latex Paints"—David C. Thornton, of Dow Chemical U. S. A.

A symposium featuring representatives from U. S. Government Regulatory Agencies (Consumer Products Safety Commission, Environmental Protection Agency, Department of Transportation, and Occupational Safety and Health Administration).

Business Session

Presentations at the business session included the following:

A review of Federation activities by John J. Oates, Treasurer, and Frank J. Borrelle, Executive Vice-President.

A report from the National Paint and Coatings Association presented by S. Robert Massarelli, a Past-President of the Florida Paint and Coatings Association.

The presentation of the Society's contribution of \$5,000 to the Polymer Science Department of the University of Southern Mississippi. These funds represented the net proceeds from the Symposium on "Water Borne and High Solids Coatings," co-sponsored by the Society and USM in February. President Moore presented the check to Dr. Gary Wildman, Dean of the College of Science and Technology at USM.

The presentation of the Society's contribution of \$500 to the Federation's Paint Research Institute. Mr. Oates accepted the check for PRI.

Reports from the Atlanta, Gulf Coast, Central Florida, and Miami Sections of the Society that attendance at monthly meetings had increased during the previous year.

A report from the Membership Committee that membership had increased 20% during the year.

A review of the prize-winning program submitted by the Southern Society in the 1975 MMA Awards of the Federation. John Kenney, of Sinnett Lacquer Mfg. Co., Jackson, Miss., made the presentation.

New Officers

Officers elected for 1976-77 were: President—Thomas E. Marek; President-Elect—Berger G. Justen, of Tropco Paint, Inc., Tampa, Fla.; Vice-President—A. Roy Neal, of Superior Lacquer Co., Toccoa, Ga.; Secretary-Treasurer—Al Hendry, of A. L. Hendry & Co., Tampa, Fla.; and Federation Council Representative—Robert F. Hall, of Georgia Marble Co., Tate, Ga.

Other members of the Executive Committee will be: George Bufkin, of the University of Southern Mississippi; Franklin Rector, of Indurall Coatings, Inc.; Fred Ball, of Eastman Chemical Products, Inc.; Vernon Sauls, of Mary Carter Industries, Inc.; Thad Broome, of Indurall Coatings, Inc.; and Bernie Einhaus, of Jim Walter Research Corp.

1977 Convention

The 1977 Convention of the Southern Society will be held at the Fairmont Roosevelt Hotel, New Orleans, March 23-26.

Info Services Conference to be Held Aug. 29 - Sept. 3

The Engineering Foundation will hold a conference on "The Technology, Management, and Economics of Information Centers and Services" from August 29 through September 3 at the Tidewater Inn, Easton, Md.

The conference is intended as an opportunity for researchers and managers to exchange ideas on current practices and concepts and to anticipate the impacts of technological developments in information transfer.

Among the presentations to be featured are:

"Information as a Commodity" — Dr. Yale M. Braunstein, New York University.

"Long-Range Prospects for Government's Role in Information Services" — Ms. Louise Becker, Library of Congress.

"Resource Management, Planning and Service Pricing in a Commercial Operation" — Ms. Kathleen Bingham, FIND/SVP.

"Distribution Techniques and the Utility of Scientific and Technical Information" — Dr. Steve Fernman, Gellman Research Assoc., Inc.

"Forecast of Technology for Scientific and Technical Information Services" — Dr. Marvin J. Cetron, Forecasting International, Ltd.

"Impacts of Innovations" — Panel Discussion.

"Implications for Government-

Sponsored Research" — Dr. Lee G. Burchinal, NSF/OSIS.

The conference fee of \$200 includes registration, meals, and double-occupancy accommodations. Registration received less than one week prior to the conference will be charged an additional \$25.

For additional information contact the Engineering Foundation Conferences, 345 E. 47th Street, New York, N. Y. 10017.

NCCA Annual Meeting To be Held May 9-12

The National Coil Coaters Assn. will hold its 1976 Annual Meeting May 9-12 at the Marco Beach Hotel, Marco Island, Fla.

Topics for discussion will include: "Measuring Temperatures on Coil Coating Lines" — Robert V. Scoyoc, IRCON, Inc.

"Gas Analysis on Coil Coating Lines" — Elliot Nesvig, ERDCO Engineering Corp.

"Strip Guiding on Coil Coating Lines" — Gary H. Matke, Fife Corp.

The NCCA's study of galvanized steel surfaces will be discussed by Dr. Henry Leidheiser, Jr. of Lehigh University; and natural gas in energy will be the topic of an address by Richard Anderson, Associate Director of the Battelle Energy Program, Battelle Memorial Institute.

Committee Activities

METRIC SYSTEMS

Progress is Being Made in Two Areas of Conversion

Progress can be reported on two items studied by the Metric Systems Committee for some time now: conversion costs and the conversion of tinting systems to handle metric sizes.

Information on probable costs has been very difficult to obtain and assemble, and is by no means complete. Even the scant figures available, however, would indicate that the probable basic conversion cost is likely to amount to a one-time only expenditure of about 0.25% to 0.5% of annual sales. This figure is also in good agreement with actual U. K. experience.

It should be noted that this is a basic figure for normal hard conversion. Where unusual conditions or circumstances exist, specific to a particular company's operation, the costs can go higher—they can also be lower. (The writer is aware of at least one example in each category.) Using common sense and adaptive ingenuity, as well as proper conversion timing, can do much to hold down costs, even in unusual situations. For example, not every piece of equipment to be converted must be new or in "mint" condition; all that is required is that it be in working order.

Tinting systems can be adapted to metric use in three ways. (It is assumed that the 1-liter and 4-liter cans will replace the 1-qt and 1-gal can sizes in both the U. S. and Canada — 1 liter = 1.057 U. S. qts = 0.882 Imp. qts):

(1) Alter the dispensing pump stroke. Lengthen it by 5.7% in the U. S. and shorten it to 88.2% of original in Canada.

(2) Alter the tinting strength of the base. Since the final color depends on the proper ratio of base pigment to colorant pigment in the dried paint film, lower the tinting strength of the base to 94.6% of the original and increase the tinting strength by 13.4% in Canada.

(3) Alter the tinting strength of the colorant. Increase it by 5.6% in the U. S. and lower it to 88.2% of original in Canada.

The first appears to be a very good solution, especially in Canada. However, it may not be usable on all U.S. machines, at least not without major alterations on some. Since shortening a pump stroke is relatively easier than lengthening it, this method should be fairly simple to adapt to most Canadian systems.

Number two is quite simple and an essentially cost-free solution for use in the U.S. It has the additional advantage of being automatic and completely foolproof on the dealer end. The hiding power of the paint will be slightly lower. The change is only slight and probably not enough to matter materially, at least not in pastel shades. For Canada, this method is not as attractive. The higher tinting strength of the base would mean heavier pigmentation and, therefore, continuous, instead of one-time-only costs.

The third method may be the most

difficult one to carry out. Among other factors, viscosity and flow characteristics of the colorant may be affected to an unacceptable degree. This does not rule out the method, which may have value in particular situations.

None of the three methods mentioned would require any alterations of the sales aids.

In other metric news, NPCA's Metric Task Force met in Chicago recently. The Metric Conversion Bill passed earlier this year formed part of the discussion. Metric Conversion is now considered inevitable. Rather than be caught unprepared at the last moment, which could have unpleasant consequences for the industry, NPCA proposes to develop and draw up a nation-wide conversion plan for the industry in due course. This plan will be submitted to the U.S. Metric Board for approval and endorsement when the latter commences full operation, probably by the end of 1976.

Full agreement was not reached on metric can dimensions. The difficulty lies with the height of the 4-liter can. This is due to the small and varying overages used with this size can. A subcommittee has been formed to deal with the matter. Other sizes posed no major problems and tentative agreement was not difficult to reach.

E. L. HUMBERGER, *Chairman*

Literature

Colorants

In response to the trend from hydrocarbon-solvent coatings to water-based systems, three new lines of colorants for industrial coatings have been developed. The 895 series, based on a polymer-type film-forming binder, is said to provide colorants of high pigment concentration with very low binder content. The 850 Chroma-Cal® polyester colorants were developed for coloring gel coats, and for use in other organic resin systems with no or very low solvent levels. The 844 series non-aqueous industrial colorants, not yet commercially available, are based on a new acrylic ester film-forming

binder, and are said to be compatible with a wide variety of solvent coatings. Write Coatings & Colorants Business Group, Organics Div., Tenneco Chemicals, Inc., Box 365, Piscataway, N. J. 08854.

Silicone Antifoams

A 30-page booklet describing the properties and applications of an extensive line of silicone antifoams is now available. The booklet describes 20 silicone fluids, compounds, and emulsions most commonly used in chemical and industrial processes, and provides comprehensive data on these products, including their

role in coatings; suggested applications and use-levels; and biodegradability, aquatic toxicity, and toxicological properties. For a copy of bulletin F-42041B, write Union Carbide Corp., Silicone Antifoams, Dept. GCB, 270 Park Ave., New York, N. Y. 10017.

Multifunctional Surfactant

A new, multifunctional, high-detergent surfactant, Alkawet® CF, has been introduced. For detailed information and samples, write Lonza Inc., 22-10 Route 208, Fair Lawn, N.J. 07410.

Calendar of Coming Events

FEDERATION MEETINGS

(May 14)—Spring Council Meeting. Sheraton Four Seasons Hotel, Toronto, Canada.

(Oct. 27-29)—54th Annual Meeting and 41st Paint Industries' Show. Sheraton Park Hotel, Washington, D. C. (FSCS, Suite 830, 1315 Walnut St., Philadelphia, Pa. 19107).

SPECIAL SOCIETY MEETINGS

(May 6-8)—Pacific Northwest Society. Spring Symposium. Bayshore Inn, Vancouver, B. C., Canada. (B. D. Lamb, Harrisons & Crossfield (Canada) Ltd., 3070 Kingsway, Vancouver, B. C., Canada V5R 5J7).

(May 19)—Rocky Mountain Society Seminar on Filtration, Dispersion, and Pumping. (Louis O. Garcia, Kelly-Moore Paint Co., 3600 E. 45th St., Denver, Colo. 80216).

(June 11-12)—Kansas City and St. Louis Societies. Joint Meeting. Colony Motel, St. Louis, Mo. (William L. Reckel, Vanex Color, Inc., P. O. Box 987, Mt. Vernon, Ill. 62864).

(June 14)—Golden Gate Society Manufacturing Seminar, "MANUFACTURING '76." Sabella's Restaurant, San Francisco, Calif. (E. "Bud" Harmon, Borden Chemical Co., 41100 Boyce Road, Fremont, Calif. 94538).

OTHER ORGANIZATIONS

(May 2-5)—Color Marketing Group. Copley Plaza, Boston, Mass. (Color Marketing Group, 1000 Vermont Ave., N.W., Washington, D.C. 20005).

(May 2-7)—XIIIth FATIPEC Congress. Convention Centre of Antibes — Juan-les-Pins, France. (G. Eyraud, Secretary, FATIPEC, 5, Rue de la Poudriere, 69001, Lyon, France).

(May 6-7)—International Symposium on Flammability and Fire Retardants. Four Seasons Sheraton Hotel, Toronto, Canada. (V. M. Bhatnagar, 209 Dover Rd., Cornwall, Ontario, Canada K6J 1T7).

(May 9-12)—National Coil Coaters Association Annual Meeting. Marco Island Hotel, Marco Island, Fla. (NCCA, 1900 Arch St., Philadelphia, Pa. 19103).

(May 10-13)—International Meeting on Radiation Processing. Cerromar Beach Hotel, Dorado Beach, Puerto Rico.

(May 11-13)—International Powder & Bulk Solids Handling & Processing Conference/Exhibition. Hyatt Regency O'Hare and O'Hare International Trade and Exposition Center, Rosemont, Ill. (A. Kozlov, Industrial & Scientific Conference Management, Inc., 222 W. Adams St., Chicago, Ill. 60606).

(May 12-14)—Fourth Annual Conference of Canadian Society for Color in Art, Industry and Science. University of Ottawa, Ottawa, Canada. (Dr. A. R. Robertson, Div. of Physics, National Research Council, Ottawa, Ontario, K1A 0R6, Canada).

(May 18-19)—ASTM Symposium on Atmospheric Corrosion. Pennsylvania State University, University Park, Pa. (Keller Conference Center, Pennsylvania State University, University Park, Pa. 16802).

(June 2-4)—Symposium on "Energy Savings through Reactive Coatings." North Dakota State University, Fargo, N. D. (Dr. Zeno W. Wicks, Jr., Polymers and Coatings Dept., North Dakota State University, Fargo, N. D. 58102).

(June 6-10)—The Chemical Institute of Canada's 59th Canadian Chemical Conference. London, Ontario, Canada. (Don Emmerson, CIC, Suite 906, 151 Slater St., Ottawa, Ont. K1P 5H3, Canada).

(June 7-11)—Principles of Color Technology. Rensselaer Polytechnic Institute, Troy, N.Y. (Office of Continuing Studies, Color Technology Program, Rensselaer Polytechnic Institute, Troy, N. Y. 12181).

(June 8-11)—International "Conference on Colour

Studies," sponsored by Hungarian National Color Committee, Budapest, Hungary. (Dr. Fred W. Billmeyer, Jr., Dept. of Chemistry, Rensselaer Polytechnic Institute, Troy, N. Y. 12181).

(June 14-18)—Short Course on "Advances in Emulsion Polymerization and Latex Technology." Lehigh University, Bethlehem, Pa. (Dr. Gary Poehlein, Dept. of Chemical Engineering, Whitaker Laboratory, Building #5, Lehigh University, Bethlehem, Pa. 18015).

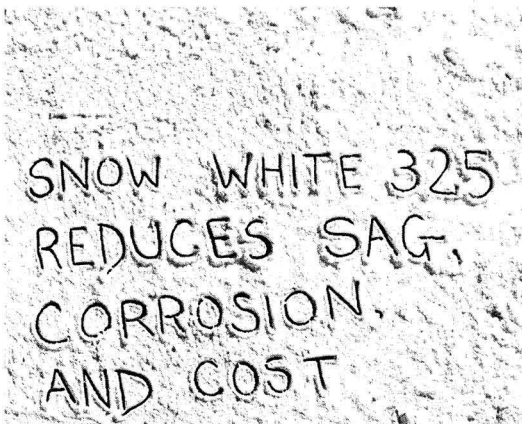
(June 15-16)—Color Technology for Management. Rensselaer Polytechnic Institute, Troy, N. Y. (Office of Continuing Studies, Color Technology Program, Rensselaer Polytechnic Institute, Troy, N. Y. 12181).

(June 21-25)—Advances in Color Technology. Rensselaer Polytechnic Institute, Troy, N. Y. (Office of Continuing Studies, Color Technology Program, Rensselaer Polytechnic Institute, Troy, N. Y. 12181).

(June 27-30)—American Society for Testing and Materials Annual Meeting. Chicago, Ill. (ASTM, 1916 Race St., Philadelphia, Pa. 19103).

(June 27-July 1)—Air Pollution Control Association's 69th Annual Conference & Exhibition. Memorial Coliseum, Portland, Ore. (APCA, 4400 Fifth Ave., Pittsburgh, Pa. 15213).

(July 18-24)—Intersociety Conference and Exposition on Transportation. Los Angeles Hilton Hotel, Los Angeles, Calif. (Thomas P. Woll, U. S. Dept. of Transportation, Federal Railroad Administration, 2100 2nd St. S.W., Room 4108, Washington, D. C. 20590).



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Coming Events (Continued)

(July 19-24)—International Conference on Organic Coatings Technology. Athens, Greece. (Dr. Angelos Patsis, State University College, CSB 209, New Paltz, N.Y. 12561).

(July 26-30)—Gordon Research Conference on "Chemistry and Physics of Coatings and Films." Kimball Union Academy, Meriden, N. H. (Dr. Alexander M. Cruickshank, Director, Gordon Research Conferences, Pastore Chemical Laboratory, University of Rhode Island, Kingston, R. I. 02881).

(Aug. 29-Sept. 3)—Engineering Foundation Conference on "The Technology, Management, and Economics of Information Centers and Services." Tidewater Inn, Easton, Md. (Engineering Foundation Conferences, 345 East 47th St., New York, N. Y. 10017).

(Aug. 30-Sept. 4)—Thirteenth World Congress for Fat Research. Marseilles, France. (A. Uzzan, International Society for Fat Research, c/o Laboratoire National des Matieres Grasses, Universite de Provence, Place Victor-Hugo, F 13331 Marseilles Cedex 3, France).

(Sept. 13-Oct.8)—Paint Short Courses at University of Missouri — Rolla. For Maintenance Engineers, Painting Contractors and Specifiers, etc. — Sept. 13-17; Fundamental Course — Sept. 20-24; For Paint Inspectors and Quality Controllers — Sept. 27-Oct. 1; Advanced Chemical Coatings Workshop — Oct. 4-8. (Norma Fleming, Extension Div., University of Missouri—Rolla, 501 W. 11th St., Rolla, Mo. 65401).

(Sept. 14-16)—"Powder Coating 4." Cincinnati, Ohio. (Society of Manufacturing Engineers, 20501 Ford Rd., Dearborn, Mich. 48128).

(Sept. 29-Oct. 1)—Convention of Scandinavian Federation of Paint Technologists. Congress Hotel Kalastajatorppa, Helsinki, Finland. (Federation of Paint and Varnish Technologists, Boks 828—2100, Copenhagen, Denmark).

(Sept. 30-Oct. 1)—National Coil Coaters Association Fall Technical Meeting. Hyatt Regency O'Hare, Chicago, Ill. (NCCA, 1900 Arch St., Philadelphia, Pa. 19103).

(Oct. 7-9)—South African Section of OCCA and Council for Scientific and Industrial Research Symposium on "Non-conventional Coatings." Port Elizabeth, South Africa. (Council for Scientific and Industrial Research, Symposium Secretariat — S.125, P. O. Box 395, Pretoria 0001, South Africa).

(Oct. 17-19)—"Adhesion of Polymers at Interfaces." Symposium jointly sponsored by Protective Coatings Div. and Macromolecular Science Div. of Chemical Institute of Canada. Montreal, Canada. (Professor H. P. Schreiber, Dept. of Chemical Engineering, Ecole Polytechnique, Montreal, Quebec, Canada H3C 3A7).

(Oct. 25-27)—National Paint and Coatings Association Annual Meeting. Washington Hilton Hotel. (Alan N. Darrow, NPCA, 1500 Rhode Island Ave., N.W., Washington, D. C. 20005).

(Oct. 26-29)—World Congress Interfinish. International Union for Electrodeposition and Surface Finishing. RAI Congress Centre, Amsterdam, Netherlands. (Organisatie Bureau Amsterdam B.V., P. O. Box 7205, Europaplein 14, Amsterdam, Netherlands).

(Nov. 2-4)—ASTM Symposium on Adhesion Measurement of Thin Films, Thick Films, and Bulk Coatings. ASTM headquarters, Philadelphia, Pa. (American Society for Testing and Materials, 1916 Race St., Philadelphia, Pa. 19103).

1977

(July 10-15)—Third Congress of the International Colour Association, "Color 77." Rensselaer Polytechnic Institute, Troy, N.Y. (Dr. Fred W. Billmeyer, Jr., Dept. of Chemistry, Rensselaer Polytechnic Institute, Troy, N.Y. 12181).

(Sept. 25-28)—First International Convention of Oil & Colour Chemists' Association of Australia. Canberra, Australia. (Oil & Colour Chemists' Association of Australia, P. O. Box 93 Punchbowl, 2196, Australia).

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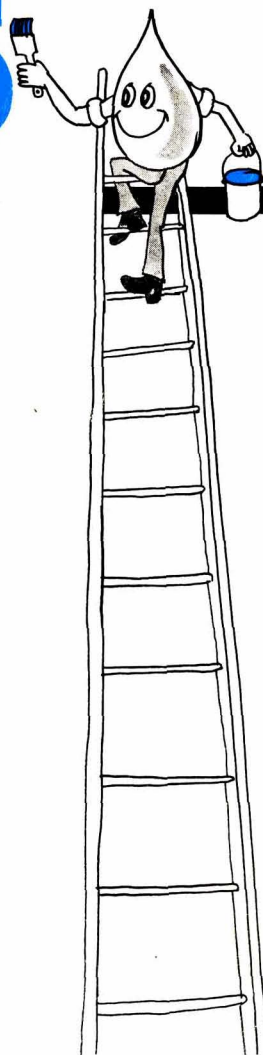
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