ENGINEERING SERVICE DIVISION

E. I. DU PONT DE NEMOURS & COMPANY
INCORPORATED
ENGINEERING DEPARTMENT
WILMINGTON, DELAWARE

December, 1976
Accession No. [redacted] 15328

REPORT OF COMPANY PROTECTIVE COATINGS AND THERMAL INSULATION MEETING

April 28-29, 1976
New Castle, Delaware and Chambers Works

Compiled by
J. R. Allen

THIS IS A PRODUCT OF THE COMPANY'S PROTECTIVE COATINGS
THERMAL INSULATION PROGRAMS

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FOREWORD

This meeting marked the 25th anniversary of our "Annual" Company Protective Coatings and Thermal Insulation Meetings.

The first meeting was held in Wilmington on June 7-8, 1950 -- and comprised only protective coatings.

The basic objectives of the first meeting have remained valid for all of the meetings since held:

- acquaint all participants with services and facilities of participating groups.
- review latest developments in the field of coatings and coating practices (and since 1972, also thermal insulation technology).
- discuss implementation of latest developments on plants.

And, to these we can add two others:

- detail specific solutions to plant problems.
- provide a forum for open discussion of plant problems and solutions.

The format of the Protective Coatings & Thermal Insulation meetings has remained about the same, with the addition, where possible, of a plant tour to highlight certain protective coating and thermal insulation methods and technology.

Organization of and participation in these meetings have been an important activity of the Engineering Service Division's Company Materials Engineering Programs which are jointly sponsored by the industrial departments and Engineering. Activities under our Company Programs also include the maintaining of clearinghouses for information applicable to Company-wide materials problems; evaluating new and improved materials of construction; developing specifications for standards; providing rapid, spot consulting on plant problems; and obtaining needed engineering information through test programs for solution to important plant problem areas.

The number of participants at these meetings has grown continually. Over 100 attended the 1976 meeting, representing each of the industrial departments, Central Research & Development, and

Engineering Departments. We had representatives from 35 plants and works in the United States. Also, the Du Pont of Canada Ajax Works and Maitland Plant and the Du Pont Puerto Rico Manati Plant were represented.

The positive response to the value of these meetings has been very gratifying. The information exchanged has continued to have marked pay-offs to the Company. Participants at each meeting ask when the next meeting will be held. Many want the meetings yearly; but, because of the time required to prepare a meeting, we now have opted to have them about every year and a half. Plans for our next meeting are under way.

In the cover letter to the first meeting report, we stated:

> "In the future it is planned to have the papers issued shortly after the meeting in order that they may serve adequately as a report on the proceedings of the meeting."

This objective continues to remain -- and we hope to achieve it next time.

We're looking forward to seeing you at the next Protective Coatings and Thermal Insulation Meeting.

- Warren I. Pollock WIP

PROTECTIVE COATINGS AND THERMAL INSULATION MEETING
RAMADA INN, WILMINGTON, DELAWARE
APRIL 28-29, 1976

J. R. Allen, Chairman

PROGRAM

WEDNESDAY, APRIL 28

Chairman: J. V. Flynn

8:45 a.m. Opening Remarks - F. J. Meadow, Works Engineer, Chambers Works

Thermal Insulation

9:00 a.m. Removable Insulation - A. O. McAlister, Engg., Design
9:20 a.m. New Insulation Materials & Systems - G. E. Lang, Engg., ESD
9:50 a.m. Use of Heat Transfer Medium - J. C. Counts, Biochem, Houston
10:20 a.m. Insulation Thickness: Current Design Practices - H. A. Moak, Engg., Design
10:40 a.m. BREAK

Chairman: G. E. Lang

11:00 a.m. Sprayed Polyurethane Foam Systems - L. L. Hash, ICD, Repauno
11:20 a.m. Thermal Insulation Maintenance - J. R. Allen, Engg., ESD
11:40 a.m. Corrosion of Steel Under Insulation: Current Problems - W. I. Pollock, Engg., ESD
12:15 p.m. LUNCH

Protective Coatings

Chairman: W. I. Pollock

1:30 p.m. Painting Drip Coolers & Chlorine Headers - M. F. Hennessey, PID, Victoria
1:50 p.m. Highlights of ESD Field Panel Tests - R. N. McCormick, Engg., ESD
2:10 p.m. New Developments in Maintenance Finishes - E. J. Zinser, F&F, Wilmington
2:55 p.m. Update on Maintenance Painting Service - L. M. Sherman, F&F, Wilmington
3:15 p.m. BREAK

Chairman: J. F. Mulvey

3:35 p.m. Painting Galvanized Steel - M. B. Harkins, Engg., Design
4:05 p.m. Changes in Protective Coatings Standards - D. W. Ferguson, Engg., Design
4:25 p.m. New Paint Evaluation Test - J. R. Allen, Engg., ESD
5:00 p.m. FELLOWSHIP HOUR

THURSDAY, APRIL 29

Chairman: L. C. Jennings

8:30 a.m. Buses Leave Ramada Inn for Chambers Works Tour
11:30 a.m. Return to Ramada Inn for Discussion of Tour - R. DeWitt, Orchem, Chambers Works
12:15 p.m. LUNCH

Chairman: J. R. Allen

1:30 p.m. FEATURED TOPIC:
Trends in OSHA Regulations - R. D. Richardson, Chief Supervisor, Environmental Control Laboratory, Chambers Works
2:30 p.m. Round Table Discussions
4:30 p.m. Reports on Round Table Discussions
5:00 p.m. ADJOURN

PROTECTIVE COATINGS AND THERMAL INSULATION MEETING
Ramada Inn, Wilmington, Delaware

ROUND TABLE DISCUSSIONS

THURSDAY, APRIL 29, 1976 - 2:30-4:30 P.M.

PROTECTIVE COATINGS

Group A - Discussion Leader: J. F. Mulvey
Recording Discussion: J. L. Taggart

Some Suggested Topics:

- Coal tar epoxy - intercoat adhesion problems
- New standards
- Starblast® - advantages
- Waterblasting

Group B - Discussion Leader: R. A. Blake
Recording Discussion: V. S. Pignolet

Some Suggested Topics:

- Cleaning and painting welds - how?
- Protection for nuts, bolts, and studs
- Painting requirements for steel to be insulated - criteria
- Painting versus galvanizing for back-up flanges

THERMAL INSULATION

Group C - Discussion Leader: J. V. Anderson
Recording Discussion: J. C. Thompson

Some Suggested Topics:

- Mineral wool versus calcium silicate - which and why?
- Corrosion under insulation - plant experience
- Thermal-acoustical insulation
- Substitutes for asbestos cloth

Group D - Discussion Leader: E. M. O'Donnell
Recording Discussion: A. G. Adams

Some Suggested Topics:

- Isocyanurate foam insulation
- Panel insulation systems
- Insulating cements - experience
- Aluminum jacketing: exterior finishes and interior corrosion barriers - plant experience

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ATTENDANCE

Biochemicals Department

J. V. Skeen	Belle Plant
J. C. Counts	Houston Plant
J. A. Stanley	Houston Plant

Central Research & Development Department

E. Lewis	Experimental Station
R. Smith	Experimental Station

Elastomer Chemicals Department

H. J. Ducote	Beaumont Works
J. P. Mulrooney	Louisville Works
K. J. Wessel	Louisville Works
H. A. Simar	Pontchartrain Works
J. C. Henderson	Wilmington
M. K. Richards	Wilmington

Fabrics & Finishes Department

R. W. Hurd	Fairfield Plant
J. R. Courtright	Marshall Laboratory
A. R. Krueger	Marshall Laboratory
W. Pregmon	Marshall Laboratory
D. L. Lamb	Parlin Plant
C. L. Cooke	West Chester, PA
J. A. Graham	Wilmington
J. F. Mulvey	Wilmington
L. M. Sherman	Wilmington
R. A. Sprout	Wilmington
E. J. Zinser	Wilmington
W. W. Council	Wynnewood Sales Office
R. W. Gordon	Wynnewood Sales Office
M. F. McCall	Wynnewood Sales Office

Industrial Chemicals Department

V. S. Pignolet	Cleveland Plant
J. D. Beckett	East Chicago Plant
P. E. Morganthaler	East Chicago Plant
W. Kronenwetter	Grasselli Plant
V. H. Markant	Niagara Works
J. Watson	Niagara Works
M. J. Grelli	Repauno Plant
L. L. Hash	Repauno Plant
W. A. Parman	Wilmington

Organic Chemicals Department

R. DeWitt	Chambers Works
J. V. Flynn	Chambers Works
L. C. Jennings	Chambers Works
F. J. Meadow	Chambers Works
R. D. Richardson	Chambers Works
J. Sgavicchio	Chambers Works
R. Shiles	Chambers Works

Photo Products Department

V. F. Burlew	Parlin Plant
L. M. Perry	Parlin Plant
C. R. Carman	Towanda Plant
E. A. Hodgdon	Towanda Plant

Pigments Department

F. Green	Edge Moor Plant
L. E. Kniffin	Edge Moor Plant
L. Schichnes	Newark Plant
H. H. Clark	Newport Plant

Plastic Products & Resins Department

C. H. Blackburn	Carney's Point Works
K. M. Patton	Carney's Point Works
G. D. Weaver	Circleville Plant
I. D. Williams	Circleville Plant
H. L. Schawl	Clinton Plant
B. D. Irby	Houston Plant
J. L. Hohman	Pencader Plant

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Polymer Intermediates Department

D. Fuqua	Old Hickory Works
R. J. McCracken	Savannah River Plant
M. F. Hennessey	Victoria Plant

Textile Fibers Department

F. H. Hixon	Chattanooga Plant
B. R. Vaughan	Kinston Plant
J. C. Groom	May Plant
W. F. O'Brien	May Plant
C. M. Gardner	Seaford Plant
J. E. Cookenour	Waynesboro Plant
E. M. O'Donnell	Waynesboro Plant
J. G. Plasky	Wilmington

Du Pont of Canada

L. C. Frank	Ajax Works
A. D. Fraser	Maitland Works
J. Mooyman	Maitland Works

Du Pont Puerto Rico

J. Aviles	Manati Plant
J. A. Innes	Manati Plant

Engineering Department

Construction Division

A. G. Adams	Chambers Works
J. V. Anderson	Louviers
R. A. Blake	Louviers
C. G. Carisch	Louviers
R. D. Ebner	Louviers
H. V. Stalnaker	FDO-Red Mill
E. R. Brooks	Seaford Plant

Design Division

W. O. Cochran	Louviers
D. W. Ferguson	Standards-Airport
A. A. Gruber	Louviers
M. B. Harkins	Louviers
H. E. Huckins	Louviers
R. L. Klausmeier	Standards-Airport
A. O. McAlister	Louviers
H. A. Moak	Louviers
R. L. M. Rice	Standards-Airport
J. L. Taggart	Louviers
J. C. Thompson	Standards-Airport

Engineering Service Division

W. L. Tamosaitis	Chambers Works
J. R. Allen	Louviers
C. Calabrese	Louviers
W. G. Caufield	Louviers
T. W. Gibbs	Louviers
D. J. Haldeman	Engineering Test Center
R. L. Jones	Engineering Test Center
G. E. Lang	Louviers
R. N. McCormick	Engineering Test Center
W. I. Pollock	Louviers

REMOVABLE INSULATION

A. O. McAlister

The demand has increased over the past few years for removable and reusable insulation covers. I am going to review the various materials and methods used in putting together removable insulation, along with some of the considerations involved in selecting the best materials for a given situation.

The primary considerations for evaluating removable covers are:

- Economics, including maintenance and energy costs as well as first cost
- Safety
- Process Requirements

One of the most important items under "Economics" is process downtime. Here, the insulation must be capable of being removed and replaced quickly.

Other items to be considered are:

- Frequency of Removal
- Durability
- Ease of Handling
- Service Conditions, such as temperature, weather exposure, and chemical contamination

These cover assemblies can be made in:

- Vendor's Shop
- Construction Shop
- Maintenance Shop
- In the Field

The removable cover can be assembled from the following materials or a combination of these materials.

Structural types of insulation include:

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- Calcium Silicate
- Marinite -- for high load-bearing situations
- Blanket or Fibrous Materials, such as mineral wool
- Parallel Reflective Metal Plates

Joints may be:

- Straight-Through Design
- Step-Type Design
- Padded or Gasketed with Flexible Insulation or Cloth

They can be finished with:

- Cloth-Reinforced Mastic
- Rigid Fiber, such as asbestos cloth cemented in place with sodium silicate
- Soft Fiber, such as glass cloth
- Suitcase or Sheet Metal Type
- Metal Mesh
- Plastic Enclosures, either hand lay-up or preformed

Fastening methods include:

- Tape
- Wire
- Bands
- Latches
- Velcro Tapes

Figures 1 and 2 show rigid insulation with a reinforced mastic finish and wired in place. No flashing is needed because this installation is indoors.

Flashing is required for:

- Outdoors
- Hosing-Down Areas
- Sprinkled Areas
- Areas where there is the possibility of chemical spills

Figure 3 shows rigid-type of insulation for removable manhole covers on large vessels.

Figure 4 shows the use of blanket-type removable insulation on a heat exchanger head.

Blanket insulation covered with metal mesh can be used for conditions where the temperature exceeds the limit for cloth covers.

Figure 5 shows the suitcase or sheet metal type with mineral wool as the insulation.

In some cases an asbestos-free marinite box could be used on pumps or similar equipment. The box can support electric tracing if required.

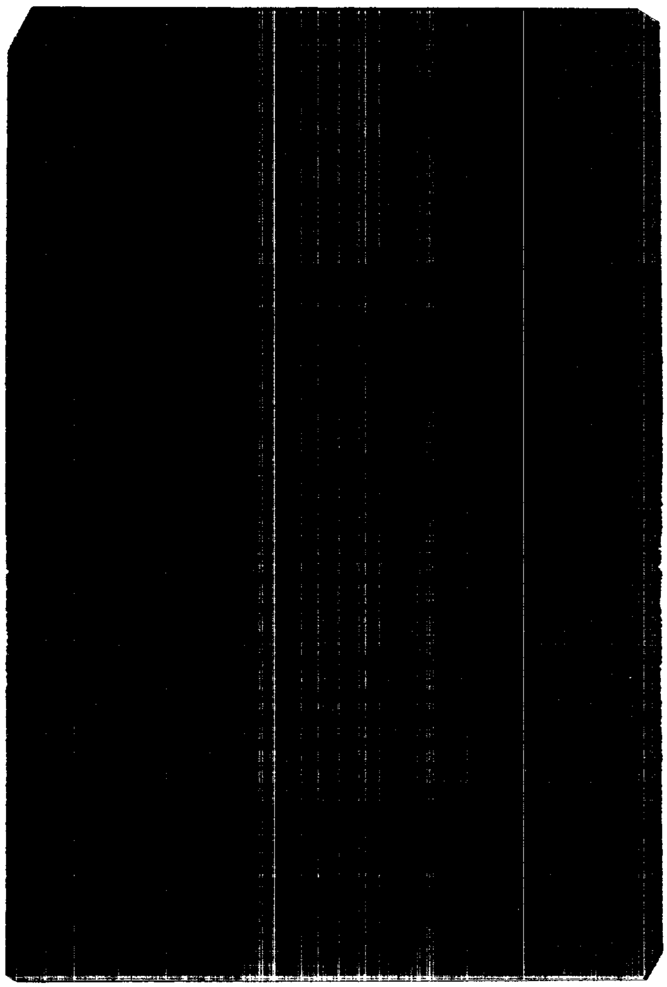
Figure 6 shows the principle of mirror or parallel plate insulation which consists of:

- Air Spaces, separated by
- Multiple Reflective Metal Sheets
- Spacers
- Outer and Inner Cases

Figure 7 shows a sample of this type of insulation.

Preformed plastic enclosures are made primarily for acoustic insulation; however, they can be used for thermal insulation also. Steps are being taken to have the fasteners attached or fixed to one-half of the cover so they are not lost when the cover is removed.

Because of the versatility of removable and reusable insulation covers, any one type can be adapted to most configurations and circumstances. However, there are many factors which must be considered and evaluated in selecting the optimum design for a specific service application. It is essential that there be close cooperation between Operations, Construction, and Design for all of the important cost and technical factors to be evaluated properly.



FIGURES 1 AND 2
Rigid Insulation with Reinforced Mastic Finish

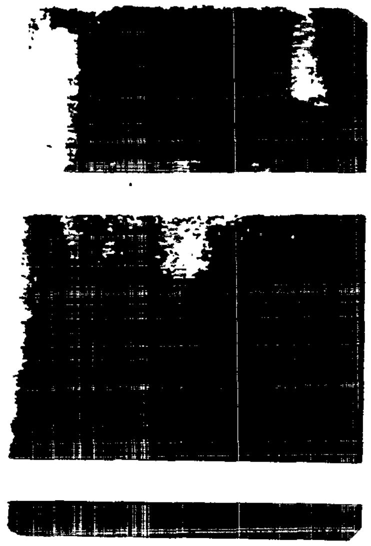


FIGURE 3 - Rigid Insulation for Removable Manhole Covers

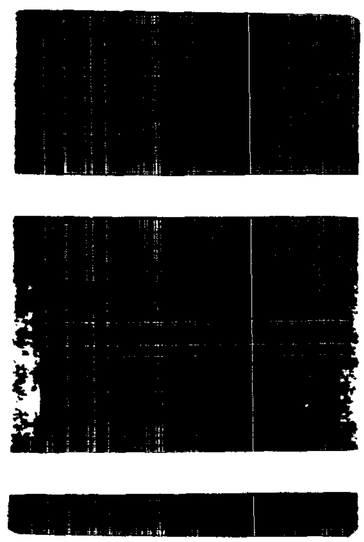


FIGURE 4 - Blanket Type Removable Insulation on Heat Exchanger Head

FIGURE 5 - "Suitcase" or Sheet Metal Covered Mineral Wool Removable Insulation

FIGURE 6 - "Mirror" or Parallel Plate Insulation

FIGURE 7 - "Mirror" Insulation

NEW INSULATION MATERIALS AND SYSTEMS

G. E. Lang

I have entitled my talk "New Thermal Insulation Materials and Systems". However, in my presentation I'll give you an update of changes that have occurred since our last Protective Coatings & Thermal Insulation Meeting.

I believe the greatest number of changes are those that have occurred in the basic thermal insulation scene.

The Celotex Corporation, which used to be the Philip Carey Co., has introduced a replacement for Careytemp 1500. It is called Celotemp 1500 and is said by Celotex to be a greatly improved product in terms of breakage resistance and ability to be fabricated without crumbling. The few fabricators I have contacted say it is a much stronger product. Celotex is quick to point out that the Celotemp 1500 is 100% reinforced with Du Pont waste nylon fibers, #501. The nylon completely replaces the glass fibers previously used.

Keene Corporation's Thermasil, one of only two nationally distributed materials we listed in our Engineering Standards as approved for use on austenitic stainless steel at or above 140°F, has been removed from the market by its parent company for economic reasons. It was rather coincidental that at about the same time the manufacture of Thermasil was stopped, we determined that it no longer passed our chloride stress-corrosion cracking test and should no longer be used on austenitic stainless steel.

A notice to this effect was sent to all construction sites and all plant works engineers. A notice was also sent to the Keene Corporation advising them of our findings and action in case they either sold the Thermasil manufacturing capability or resumed production.

For many years a number of you have heard me "crying the blues" about no across-the-board substitute for Johns-Manville's Marinite or woven asbestos cloth. We are still in that position with the asbestos cloth, but we finally see some daylight on the Marinite.

Johns-Manville has introduced Marinite XL, a totally asbestos-free material. They advise that it is almost as structurally strong as the asbestos-bearing Marinite,is as machineable as its predecessor, and is about equal to the density of their intermediate weight Marinite. By the way, the XL is Roman numeral 40, which is its nominal density. At this time they

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plan to produce only the one density and at only 1/2-, 3/4-, and 1-inch thicknesses; but board sizes will be the same as they presently produce. It is said to be fully available on the market, but some of you may have a more accurate statement on that. I have placed an order for trial samples to do machining and screw holding power tests, and I'll report results when complete.

Eagle-Picher's Epitherm 1200 is certainly new new, but I suppose its major promotion has been since our last meeting. I hope to get some feed back from those of you who have had experience with it. I don't recall seeing it at any plant sites.

I believe that generally around Du Pont the mineral wool and glass fiber materials are not popular.

Certain-Teed 850, high-temperature glass fiber insulations by Certain-Teed Products, has received a large amount of advertising in the last year; but we are having difficulty getting them to answer a few specific technical questions. Their material turns from yellow to white when put in an oven at 850°F, which indicates it has lost all its binder, but it does not expand or "grow". Our concern is that the areas which lose the binder at high temperatures will be subject to deterioration by normal pipeline vibration. The manufacturer has avoided this subject. If any of you have any information on this, I would appreciate hearing from you.

A relatively new material in terms of the last couple years is the polyisocyanurate foam Trymer CPR9545 by the Upjohn Company. This material looks and feels very much like a conventional polyurethane foam, and its physical and thermal characteristics are very similar except its high resistance to fire penetration and ability to function well on higher temperature surfaces. Its flame spread index without a coating is below 5; and with a Hypalon® or insulation mastic coating, it is below 75.

As tested on a radiant panel heat source, cement asbestos board registers 1, and dried red oak registers 100. CPR9545's main claim to fame is its ability to perform well at higher service temperatures without swelling or distorting and by maintaining its thermal insulating efficiency.

Its major promoter on the East Coast, Viking Insulation of Sparta, NJ, is pushing it for surfaces to 350°F. We have limited it to a maximum of 300°F in our Engineering Standards. Figure 1 shows the results of exposure of this material to a fully insulated 4-inch hot pipe at controlled temperatures of 250°, 300°, and 350°F for the accumulated times shown. Aside from color, the only other noticeable change was an undesirable increase in the friability of the hot side surface between the 300° and 350°F exposures, leading us to set the 300°F maximum service limit for Du Pont use.

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The vendor's interest is to promote this foam insulation for up to 125-pound steam service and avoid the present dusty, crumbly calcium silicates and the damage and wetness-prone glass fiber insulations. We feel we need more service experience before we move about the 50-pound steam or 300°F applications. Some of our plants are finding the Trymer 9545 very desirable for the low-pressure steam service from the standpoint of negligible breakage in shipping and storage, less weight to handle, ease of fabrication, and space saving by its higher thermal efficiency. Our experience so far indicates this material will make a very good alternate for the costly and difficult to fabricate Foamglas in dual temperature service.

In addition to changes to basic thermal insulations, we have the continued, successful use of pre-engineered, prefabricated panel thermal insulation systems on vessels. Two of the more prominent brand names in this field are Thermacon and Romet.

As we have defined these systems, they consist of the basic thermal insulation, factory adhered to a sheet-type weather barrier so the combination or complete insulation system is applied in the field as a unit in one operation, versus the two or more operations of our conventional systems.

The area covered by the typical panel is usually ten or more times that covered by the standard insulation block. The panel size is limited primarily by the total weight and handleable dimensions of a single panel. Figure 2 shows the relative simplicity with which the Thermacon panel system installs on one of four storage tanks at Old Hickory. With only a few nozzles and a little planning, it adapts well to a low sloped conical roof.

Figure 3 shows the completed roofs, completely flashed and ready for operations. I might mention that men worked standing directly on top of the insulation with no damage whatsoever.

Figure 4 shows the completed vessels, which the plant project engineer reports have no damage through the 32-mil weather barrier in three years of operation. There are some sizeable dents from construction work in the immediate area, but no punctures. The engineer stated he believes this insulation system will be maintenance free for the life of the vessel. We certainly can't say that about our conventional insulation systems.

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One particular vessel at Chambers Works didn't fare as well, as shown in Figure 5, but did excellent compared to our standard insulation systems in the immediate vicinity which were heavily damaged. This vessel was directly across the road from a hydrogen reduction unit explosion and sustained only a few shrapnel punctures. The rest of the panel insulation installation remained intact and weatherproof. The punctures are easily repaired by cutting out the damaged sections and inserting a section of the panel with the jacket laps thoroughly flashed with compound and sheet metal screwed into place. In this case the plant had no extra Thermacon panels, so they filled the cut-out with glass fiber insulation, as shown in Figure 6, and covered it with a taped-on aluminum foil. This is not a recommended procedure, but it can work.

Romet, the other panel system I referred to, is particularly adaptable to rectangular and pyramidal shapes. Rather than the smooth, flat sheet metal weather barrier of the Thermacon system, Romet predominantly uses a corrugated box rib metal sheet for greater stiffness when installed on large, flat surfaces.

Design of gutters, or guttering, as these people refer to it, is a very important part of the pre-engineering with this type system to prevent rainwater or melting snow from being inadvertently conveyed into the insulation instead of away from it. The simplicity and appearance of insulating large, flat surfaces and ease of change of direction where flat planes intersect are advantages of the panel systems.

Our experience so far indicates an approximate 50% savings of field labor when using the panel systems compared to the conventional systems. Even though the materials for a complete panel system are somewhat costlier than our standard materials, we still end up with at least a 25% overall installed cost savings.

A new approach within Du Pont to a particular thermal insulating problem is the use of "soft" or "flexible" insulation covers, which Mac McAlister has detailed. These are also thermal insulation systems in that they comprise the total insulation application of basic thermal insulation and its protective covering or finish.

I have been working on the modification of the conventional turbine blanket to develop prefabricated polymer pump covers. Figure 7 shows the first two prototypes designed for Type 9 spinning machine polymer grid units. The one on the right is a six-piece assembly which has, at this time, been considered impractical because of too many pieces to handle and too many joints to keep tight. The other, a three-piece unit, is undergoing tests at our Chattanooga Textile Fibers Plant. Figure 8 is a close-up of the three-piece unit.

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Two two-piece units will be evaluated at the Martinsville Plant in the near future, and fabrications for polymer pump covers of a much simpler geometry will be evaluated at the Cooper River and May Plants.

The advantages of these insulation systems are that they are totally asbestos free; they should be much more abuse resistant than our conventional calcium silicate fabrications; and they provide for the mechanical fastening of their protective jackets, eliminating the need for the aggressive sodium silicate adhesive which is so readily compatible with woven asbestos cloth but which actively attacks substitutes for asbestos cloth. They are also more thermally efficient than calcium silicate removable, reusable covers on an equal thickness basis.

Until now, polymer pump covers have always been subject to disproportionately high maintenance because of the very frequent rough handling to which they are subjected.

With the almost mandatory requirement of using only asbestos-free materials, our present methods of fabricating these covers using calcium silicate jacketed with glass cloth having a self-contained adhesive can only result in at least a fourfold increase in the maintenance level for these units.

Another thermal insulation system, which is not new but which is receiving increasing activity within Du Pont, is sprayed polyurethane foam. The economics and technical specifics will be discussed by Lane Hash later, but I would like to emphasize from a materials standpoint that you should choose your sprayed polyurethane foam system carefully for fire safety. Of all of the technical aspects of a sprayed foam system, this is the one that gets the least attention from the insulation contractor and, many times, his customer. Made available to me was a set of slides of a fire that had occurred against a fuel oil storage tank. Fortunately someone had made the proper selection of polyurethane foam in conjunction with the correct weather barrier. Figure 9 shows a 40-foot-diameter by 50-foot-high, No. 6 fuel oil storage tank at a steel mill in eastern Pennsylvania. It had a 1-1/2-inch thickness of Owens-Corning Fiberglas #322 sprayed polyurethane system applied over a previously painted but cleaned surface. The foam was then coated with 30 mils dry film thickness of black Monolar, a Hypalon® mastic. Unfortunately, the operator filling the tank allowed it to overflow and form a pool of oil out to approximately 15 feet from the tank wall. The fun started when the operator, using an end-loader to build a dike with slag from the steel mill, used a load of hot slag and the oil ignited. It was ten minutes before the fire company arrived, but they had it under control in another 20 minutes. The area that was blistered and burned and will require replacement ran approximately 12 feet circumferentially and 15 feet high, as shown in Figure 10. In bordering areas where the Monolar was less blistered, the foam underneath is in relatively good condition, as shown in Figure 11. The foam in the center of the fire zone was only discolored or charred for a depth of 1/4 to 3/8 inch, as shown in Figure 12.

This tank sat on a rise and only a short distance from the center aisle of the steel mill main building. Some people are just lucky.

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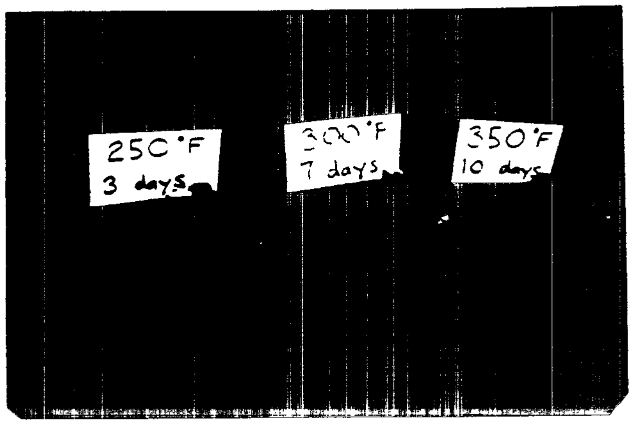

FIGURE 1 - Polyisocyanurate Foam - Heat Exposed

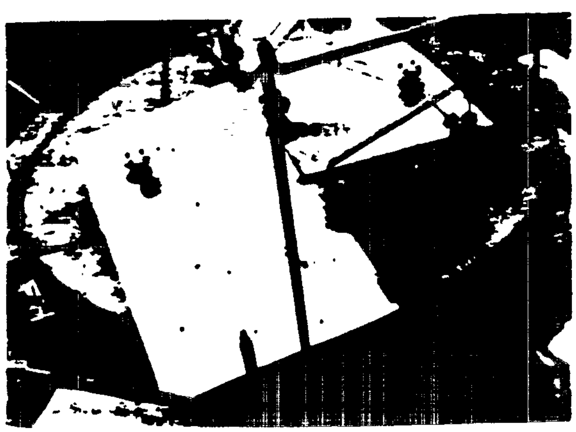

FIGURE 2 - Thermacon System - Tank Top Insulation Being Installed

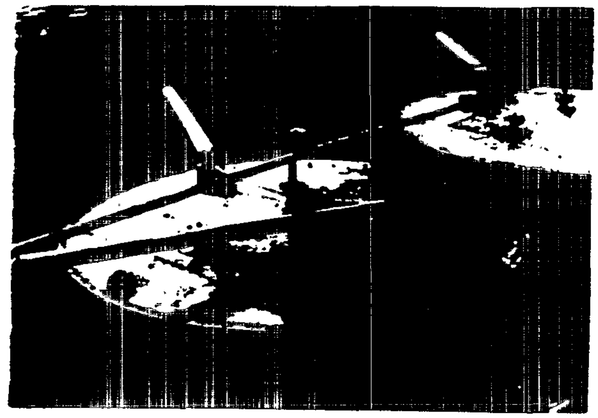

FIGURE 3 - Thermacon System - Tank Top Insulation Complete

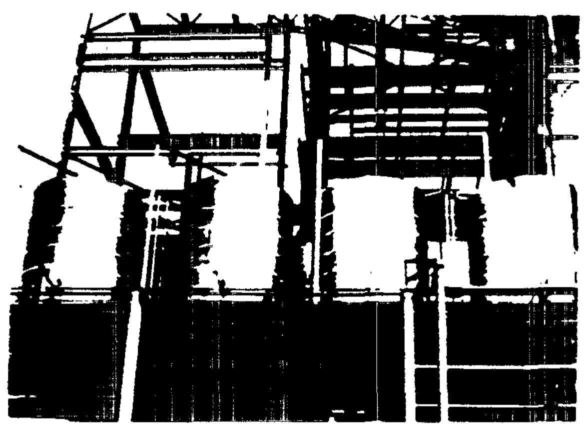

FIGURE 4 - Thermacon System - Tank Insulation Complete

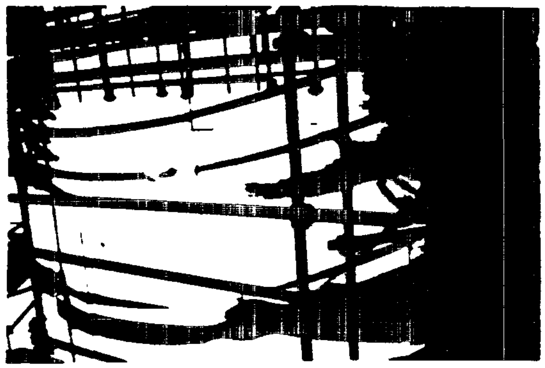

FIGURE 5 - Thermacon System - Explosion Damage

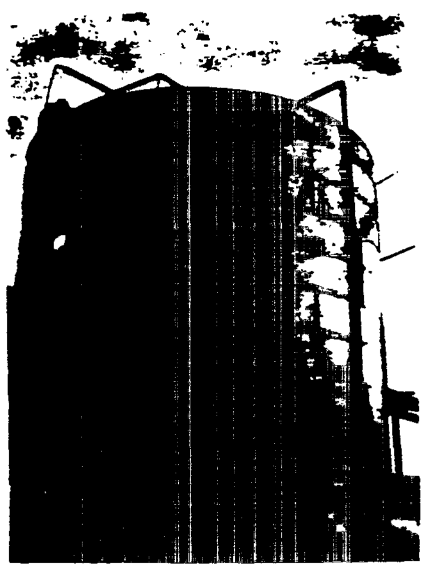

FIGURE 6 - Thermacon System - Explosion Damage Repairs

FIGURE 7 - Modified Turbine Blankets on Polymer Grid Units

FIGURE 8 - Three-Piece Modified Turbine Blanket on Polymer Grid Unit

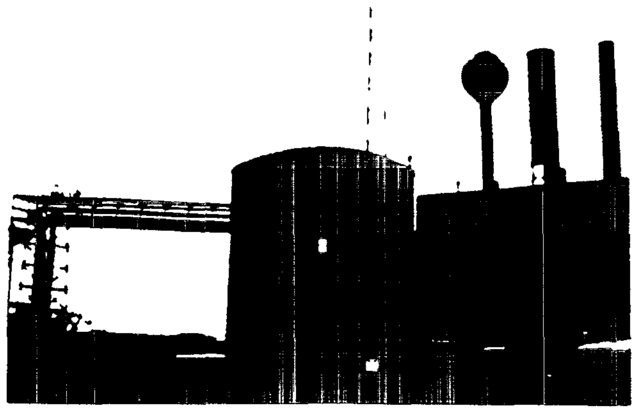

FIGURE 9 - Spray Polyurethane Foam Insulated Fuel Oil Storage Tank

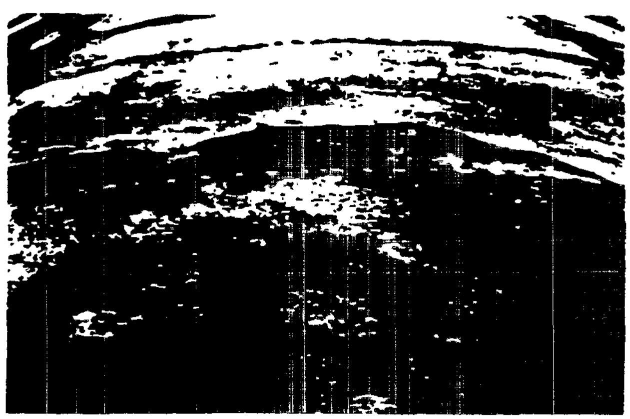

FIGURE 10 - Fire Damage of Spray Polyurethane Foam and Weather Coating

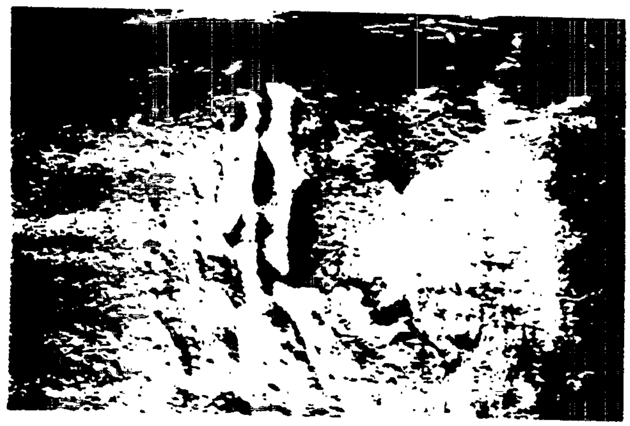

FIGURE 11 - Fringe Area Protection of Foam by Hypalon® Mastic Coating

FIGURE 12 - Minor Depth of Foam Damage in Fire Area

USE OF HEAT TRANSFER MEDIUM (HTM)

J. C. Counts

The need for heating, cooling, or maintaining temperatures of pipelines and equipment is required in almost every unit operation. It may be required for reaction kinetics or for improvements to or maintenance of physical properties. Selection of the best, most practical method requires thought and economic evaluation. The most common methods used are:

- jacketing
- internal tracing
- external tracing

Jacketing

Jacketing consists of dual wall construction, in whole or in part, surrounding the equipment or pipe. Fluid, usually steam for heating and brine for cooling is passed through the annular space to control the process to the desired temperature.

The main advantages of jacketing are:

- predictable transfer rates
- fast response due to the relatively large intimate contact area
- even temperature distribution
- low Δt required

The disadvantages are:

- high initial cost
- long delivery of valves and related equipment
- difficulty of fabrication and repair
- greater space requirements for the jacket and jumpers
- the ever present problem of cross contamination should the common wall fail

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Internal Tracing ("Gut Line") or Coils

Internal tracing, like jacketing, consists of dual wall construction but with the heating or cooling fluid supplied to the internal tracing and being surrounded by the material to be heated or cooled. The advantages of internal tracing or coils are essentially the same as jacketing but cost less and require less insulation thickness because of the smaller Δt to atmosphere.

The disadvantages are that:

- the flow area is reduced by the internal tracer
- the stuffing boxes or glands are needed and must be maintained
- "pigs" cannot be used to clean the interior of the pipe
- higher Δt is required because of the smaller heat transfer area available
- exotic materials of construction frequently must be used for the tracer as well as the pipe
- there is the problem of cross contamination should the common wall fail

External Tracing

External tracing usually consists of tubing or pipe held in close proximity to the external surface to be heated or cooled with wires, tape, bands, or welding.

The advantages of this system are:

- the cheapest first cost
- no special materials of construction required
- it is easy to fabricate, install, and repair with materials readily available
- no cross contamination hazard exists

The disadvantages are that it:

- relies on radiation and convection heat transfer which mostly limits the applications to temperature maintenance
- results in uneven temperature distribution and unpredictable heat transfer rates

External Tracing with Heat Transfer Medium (HTM)

Heat transfer medium (HTM) was developed to modify external tracing systems to retain the advantages of jacketing or internal tracers while eliminating most of their disadvantages. HTM is formulated from materials with high thermal conductivity like graphite, metal powder, etc., with enough binder to make it a paste-like consistency for handling and application ease.

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The HTM is placed in the voids or air spaces present between tracers and pipe or equipment to form a thermal connection for more efficient heat transfer by conduction. Normally the fillet is extended about three tracer diameters at the base.

The advantages of the HTM external tracer system are:

- intermediate first cost
- simple to install and repair; can be added to existing lines and equipment in the field
- fast heat-up similar to the more expensive systems
- even temperature distribution
- low Δt required versus standard external tracing
- no possibility of cross contamination

Figure 1 shows the comparison of heat-up and approach temperatures using various heating systems on a 2-inch pipe insulated with 1-1/2-inch-thick Code 102 insulation.

Since the conventional tracer systems rely on radiation and convection heat transfer, tracer location is critical. Tests have shown that location of the tracer in the HTM system is not too critical, which makes installation simpler and more economical.

Types of HTM

There are a number of types or grades of HTM available. Physical properties of temperature limits, water solubility, shelf life, and other pertinent data should be considered for proper selection. The material is available in:

- bulk -- cans or pails
- cartridges
- tape with paper release backing
- partially polymerized, extruded, preformed strips

Application of HTM

- Bulk HTM is applied with plain or special trowels, gloved, or in the "Channel Trace" system.
- Cartridges can be used in hand- or air-operated caulking guns.
- Tape material is placed next to the tracer and pressed into groove by finger pressure on the paper backing. The paper is peeled off when multiple layers are required.

- Extruded, preformed strips of "Snap-Trace" are placed over the tracer and snapped into place. A light-gauge channel is used to contain it until cured.

When to Use HTM Systems

HTM systems require economic evaluation for proper selection as well as a knowledge of the process requirements.

HTM systems should be considered where:

- heat-up or melting capabilities are needed
- multiple conventional tracers are indicated
- temperature and quantity of heating or cooling media are limiting
- hot or cold spots might cause product degradation or freezing
- localized overheating could cause failure of base material or corrosion-resistant liners or coatings due to exceeding temperature limits or causing thermal stresses

Case History - Houston Plant

An internal steam tracer failed in the sulfur unloading line from the barge dock to the storage tanks. When the steam was turned off to eliminate venting through the storage tank, cooling of the steam in the line created a vacuum and drew molten sulfur into the tracer through the failure point. As a result, 565 feet of the 8-inch transfer line with 1-1/4-inch internal pipe tracer became completely plugged with solidified sulfur (Figure 2). It included 465 feet on sleepers, 3 feet above grade, and 100 feet on a pipe rack 16 feet above grade. Normal maintenance procedure would be to remove the failed section of line and replace it in kind. Evaluation of alternates suggested that the use of an HTM system on the existing line would be a more economical solution. Sufficient heat transfer area would be provided to melt the sulfur and the internal tracer would be plugged and abandoned in place.

Design Conditions (Worst Condition)

Ambient and line temperature	20°F
Wind velocity	20 mph
Steam pressure available	50 psig
Required operating temperature	260°F
Required heat-up time	reasonable -- when sulfur barge is scheduled for unloading

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Solutions Offered by "Computrace" (Thermon Mfg. Co.)

System	Pipe Temp. °F (Final)	Trap Dist. ft	lb cond/ft Tracer	Heat-Up Time hours
1-1/2" O.D. tubing tracer	245.8	159.6	0.1385	over 24
2-1/2" O.D. tubing tracers	265.4	224.0	0.0812	24.3
3-1/2 O.D. tubing tracers	274.0	282.5	0.0564	13.9
1-3/4" O.D. tubing tracers	256.4	341.2	0.1556	over 24
2-3/4" O.D. tubing tracers	270.5	462.7	0.0965	15.8

Insulation to be 1-1/2-inch-thick calcium silicate.

The operating department was contacted and agreed that a 24-hour maximum heat-up time would be satisfactory.

Since the pipe was essentially a straight run, it afforded an opportunity to try the two latest HTM systems, "Channel Trace" and "Snap Trace". Both utilize a light-gauge sheetmetal channel over the HTM to provide protection from the elements prior to insulation and weatherproofing and also to minimize HTM pulling away from the surface due to thermal expansion-contraction and/or poor surface preparation. The manufacturer claimed installed cost to be competitive with conventional methods using bulk material where the service is critical.

"Channel Trace" materials were $1.60 and "Snap Trace" materials were $3.00 per foot for the 2-1/2-inch tubing tracer system. Results were inconclusive as to which is the more economical system. Labor cost was more a function of the mechanic than the system. Total cost of the job averaged $24.70 per foot which includes make ready, new steam traps and supply system, HTM, insulation, scaffolding, pressure testing, welding plugs in abandoned internal tracer, and clean-up. Total cost of replacement with internal tracer (in kind) was estimated at $47.60 per foot, and a 10-inch by 8-inch jacketed system was estimated at $125 per foot. There would also have been a decontamination and disposal problem with the plugged dismantled line.

Phases of the sulfur line job:

1. Traps added.
2. Surface preparation by wire brushing.
3. Filling channel from bulk HTM (Figure 3).
4. Striking excess material from channel (Figure 4).
5. Placing filled channel over tracer (Figure 5).
6. Banding channel to compress HTM into void (Figure 6).
7. "Channel Tracer" ready for insulation (Figure 7).
8. Blocking used to stabilize oversize insulation (Figure 8).
9. Installation of "Snap Trace" on tracer (Figure 9).
10. "Snap Trace" ready for insulation.

HTM can be used effectively on pumps, valves, and tanks. It is also used effectively with electric tracing systems.

The Process Insulation Standards Subcommittee is presently reviewing Standard SN206P. Any input from HTM application experiences in the field would be greatly appreciated. Of value would be:

- Do you use HTM?
- Purpose?
- Quantity used, each type
- Brand or brands used
- Problems or successes experienced

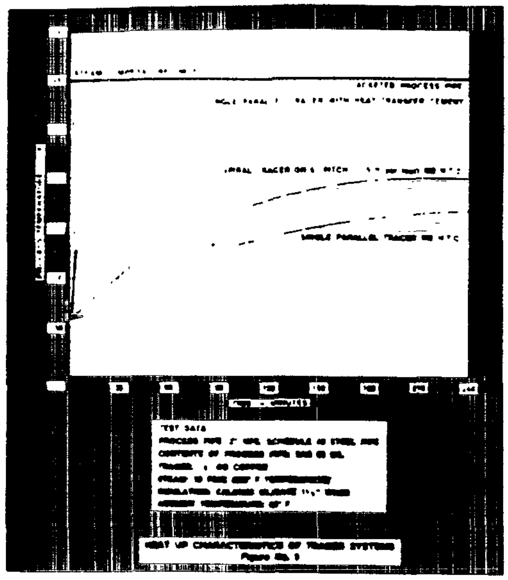

FIGURE 1 - Heat-up Characteristics of Tracer Systems

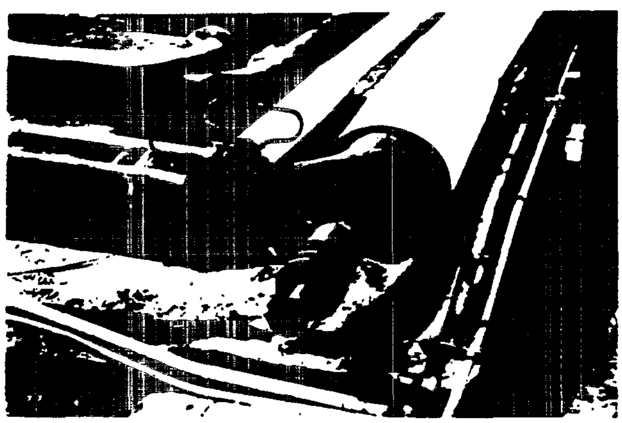

FIGURE 2 - Internal Tracer Plugged with Solidified Sulfur

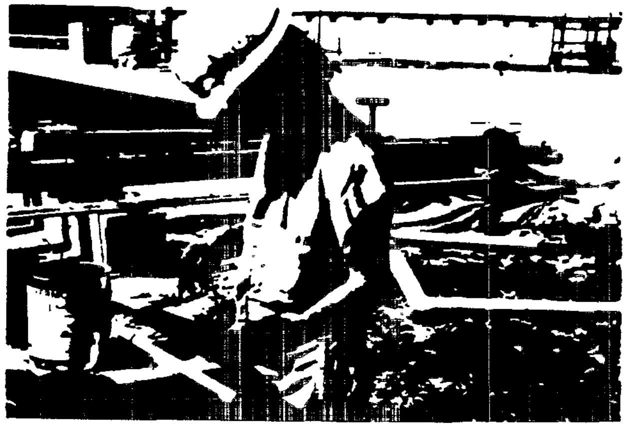

FIGURE 3 - Filling Channel from Bulk HTM

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FIGURE 4 - Striking Excess Material from Channel

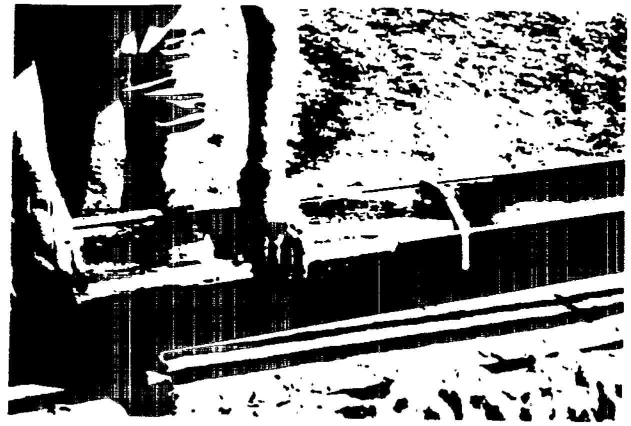

FIGURE 5 - Placing Filled Channel over Tracer

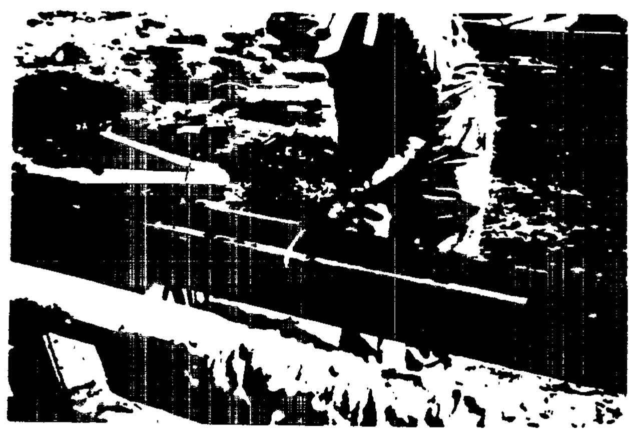

FIGURE 6 - Banding Channel to Force HTM into Void

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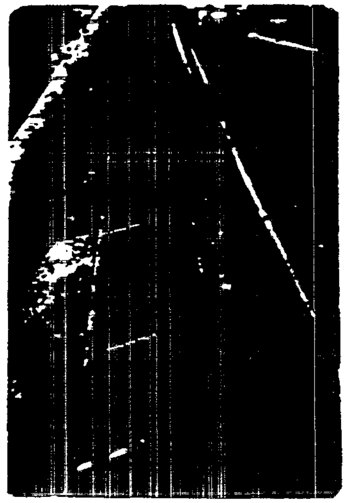

FIGURE 7 - "Channel Tracer" Ready for Insulation

FIGURE 8 - Blocking Used to Stabilize Oversize Insulation

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FIGURE 9 - Installation of "Snap Trace" on Tracer

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INSULATION THICKNESS: CURRENT DESIGN PRACTICES

H. A. Moak

In terms of economic thickness, I'm not sure I will have many answers for you, but hopefully there will be some things for you to think about. I think we first presented "economic thickness" to this group in Houston in 1972. I wish I could say we had the foresight to predict the energy crisis and all of the things that have followed; really, we didn't. The fact is that we got into it because of the economics. Because of the attention this subject has received, there have been many publications, and not only by government agencies; it seems everybody is getting into the act.

When most people think of economic thickness, they think first of energy conservation and then thickness. That is only part of the story. In addition to thickness of insulation and the type of insulation material, the "k" factors must be considered also. As long as we are mentioning "k" factors, I think this is something that is frequently misunderstood. People are prone to take data as published in any manual or publication and accept it as gospel without realizing what is involved, how the numbers are obtained, and if they meet the requirements. The "k" factor numbers are an average for conditioned laboratory samples. They do not truly represent what you are actually putting on and using in your day-to-day work. Sometimes, just out of curiosity, take the published data you have and see what test procedures they refer to. Sometimes their cross references are worse than some of our standards in terms of going from reference to reference, but I think this effort will be somewhat of a revelation to you. You should consider, also, that people who manufacture products are competing with each other; therefore, the number they publish is the one which makes their product look the best. Another consideration is aging. With some materials, the "k" factor will tend to change with time. The most prominent of those is urethane. Most of the published values are in the 0.11 to 0.13 range. That is the number as the urethane is originally foamed. However, after about six months of aging, that figure increases about 30% to 40% to a value nearer 0.19. Another item frequently overlooked is moisture and moisture content. I mentioned earlier that the value for materials as you order them is based on the manufacturer's published data for a dry, conditioned sample. The material as you receive it has a percentage of moisture in it.

The following tables will give you some idea of the thermal conductivity of water or moisture.

TABLE 1

THERMAL CONDUCTIVITY OF WATER
Btu/in/hr, Ft^2, °F

Temp., °F	K_T	K^1 $^{100}_{T}$
100	4.31	4.31
75	4.14	4.14
32	3.84	x
32	15.5	10.5
0	16.7	13.4
- 50	18.9	17.0
-100	21.3	20.4
-150	24.2	23.9
-200	27.8	x

TABLE 2

MOISTURE INTENSIFICATION FACTORS

Moisture % Volume	Intensification Factor "Fm"	Correction Factor "f"
0	0	1.0
0.05	0.020	1.020
0.1	0.038	1.038
0.2	0.074	1.074
0.3	0.108	1.108
0.4	0.140	1.140
0.6	0.198	1.198
0.8	0.251	1.251
1.0	0.30	1.30
2.0	0.48	1.48
3.0	0.61	1.61
4.0	0.70	1.70

In Table 1, you can see that at 100°F the thermal conductivity of water is approximately ten times that of the most commonly used insulation materials. This condition is bad enough, but it gets even worse when the water turns to ice. At that point it increases another 400%. If you take these numbers and multiply them, you find the conductivity of ice is approximately 40 times that of insulation. I have included these data because I've seen several instances where people deliberately let cold systems "ice up" because they believe it is a good insulator. It's your money, and if you want to go along with it -- help yourself.

Table 2 shows moisture intensification factors for moisture content up to 4% by volume. At this moisture level, the multiplier is 1.7. George Lang and I have checked some calcium silicate material at the Test Center that had been sitting indoors for about a year. The percentage of moisture was approximately 5% by weight. This gives you some idea of what you're running into.

There are three major factors involved in economic thickness calculations which determine how much you can really afford to put on a system. These factors are: labor, material, and the cost of energy. Too many times the labor calculation is made by considering only the base wage rate. This can produce misleading results. Wage rates vary widely depending on who does the work, where, and when. If the Engineering Department does the work, it may be either an open or closed shop rate. The labor cost can also vary if you are working with plant forces. Many people have work done by contract; and even there you have to recognize the differences in the types of contracts. It is frequently convenient for you to work through a time and material basis, but it is not necessarily your most economical approach. Also, you have cases where you're working on a unit price. This has some advantages -- at least you know what the figure is supposed to be. The type contract which appears to have the most advantages is a lump sum. Prices of these can vary depending on the area of the country. Also make sure you don't overlook any of your distributes. It depends on how your particular site handles the accounting as to which levels of supervision are included in direct labor. Make sure all pertinent costs are included.

Productivity is a vital factor and must be recognized even though it can vary widely, as Jim Counts pointed out earlier. Productivity is also affected by the geographical area of the country. This is particularly evident in contract bidding. We have talked to quite a number of contractors; and even in the same section of the country (consider the Houston area as an example), the same contractor will bid the same job differently for Houston than he will for Beaumont or Sabine, even at the same wage rate. So, productivity does have to be recognized. Craft availability also has an effect. If you are going to a job with ten men or less, you don't have the problem you do if you are going to go up to a 100-man force. The project type has an effect, too, depending on whether it is a new or existing facility.

Moving on now to material cost, I have broken this into two categories. One category includes the obvious costs, such as a foot of material, so many square feet of covering, or so many gallons of mastic. Those areas I wouldn't worry about too much. However, the second category is important. These are the "hidden costs", and they will tend to trap you. One of the most significant of these is the pipe and fitting factor. If you base your economic evaluation only on how much it costs per foot of straight pipe, the evaluation can be off considerably.

Very seldom do you have a line such as the one Jim Counts had where there are several hundred feet of straight-run piping. Most of the piping has a more intricate configuration with tees, valves, fittings, hangers, and instrument connections. These interruptions increase costs rapidly. The cost of this type will be in the range of 40% to 60% above the cost of a foot of straight pipe insulation. I don't know how many of you had the opportunity to look at a contract which includes the multiplier factors for elbows, flanges, tees, and valves. In the past, these have led to misunderstanding as well as cost overruns. As an example, if your contract has a valve multiplier of 6, you may assume the valve insulation will cost six times what a foot of straight pipe costs. Read a little closer. That "6" applies only to the body of the valve -- it doesn't take into account the flanges on it. If you have a flanged body valve, the flange multiplier may be 4.5. Now, when you include the inlet flanges, outlet flanges, and body flanges, the cost to insulate the valve is 19-1/2 times what the foot of straight pipe costs. This is why a complete analysis is important, and we want you to be aware.

Another economic impact item has to do with increased pipe cost -- part of the cost increase comes in the hangers, depending on whether you are hanging against the pipe directly or whether you are hanging outside the insulation. As you increase insulation thickness, if you are hanging from the outside, you will find that the hanger price has increased as the insulation thickness increases. Not only does the cost of the pipe hanger increase, but also the rod and the beam clamp at the top. Frequently the hanger cost can exceed the cost of the pipe. Another item involves valves, particularly small ball valves. Where they are imbedded in insulation you have to make some special provision to get the valve handle extended outside the insulation, sculpture out around the handle, or make sure that you order valves which have an extended bonnet. Some of the manufacturers have the extended bonnet along with an extended price.

The third item we mentioned was the cost of energy. There is certainly a variation of that factor depending on the type of fuel you are burning. For the Gulf Coast area, where they are still fairly attractive. On the other hand, intrastate gas which is not price regulated has jumped severalfold. Interstate gas, which is regulated, has not increased as rapidly. However, regardless of how cheap it may appear to be, if you can't get it, then you have another problem. "As-fired" costs depend on the efficiency of the converter. The efficiency of a steam boiler normally is higher than the efficiency of a Dowtherm generator. However, where you are running turbines, etc., with steam, they can consume as much as 15% of the generated energy. Assuming you have an 85% efficient boiler, and 15% consumption by turbines, 28% of the energy never gets out of the powerhouse. Therefore, fuel which originally cost $1 is now $1.38 before it ever gets out of the powerhouse. So, in your evaluations, make sure you are getting the real cost of what you are putting into the system and the value you are trying to save.

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In addition to the Company information for evaluations, there are commercial data available. You may have seen some or seen references. I would be surprised if you haven't been bombarded with literature that the manufacturers distribute. One of the most common references is ECON Program. This program was done by York Research Corporation. They have been quite prominent in the field for several years. The ECON-I program involves a manual of approximately 150 pages which takes a little bit of getting used to. There are several significant cost items which were not included.

ECON-II is an eight-page pamphlet excerpt from ECON-I and is distributed free of charge by major manufacturers such as Owens-Corning or Johns-Manville. Included is a tabulation of insulation thickness, by type of material, in 100-degree increments of temperature range. Based on everything we've seen, using ECON-II can be a mistake because insulation thickness based on temperature alone is not necessarily the answer to the problem.

Another question frequently asked has to do with "retrofit". TIMA (Thermal Insulation Manufacturers Association) has published a 56-page manual entitled "R-ECON" on this subject. We have had many questions from various plants relative to how much insulation should be added to existing systems. So far, of their evaluations of which I am aware, I don't think any of them have justified going back and putting more insulation on an existing line. One of the things that makes adding insulation difficult is space. Frequently you don't have a choice. There are also many cost factors other than just how much an additional foot of material costs to put on.

At this point, let me digress for a minute. Earlier I referred to moisture. We all know moisture and insulation systems are not compatible. Increased insulation thickness and moisture may counteract each other. The thicker the insulation, the lower the temperature near the outer surface. Therefore, when moisture gets into the system, and we all know what it does, there is not sufficient temperature to evaporate it all. Therefore, you are not getting the calculated effect of all the additional thickness.

Another publication which should be available soon is the "Economic Thickness for Industrial Insulation" manual which York Research has completed for the Federal Energy Administration. The draft copy of the manual has 208 pages. This book is essentially an updated and more complete version of ECON-I.

The next source is computer program data. Many manufacturers offer a free evaluation for specific applications such as tanks. Their programs do not appear to be quite as broad as a program we have within the Company. The program we use has been developed over several years. Many people have been involved and contributed valuable ideas which allows our program to cover a wider field than those of the manufacturers.

Another item of data that can be helpful to you is Standard SN5D, which has been developed and issued since our last meeting. It provides specific data as well as some "rule of thumb" guidelines. Also, the back pages of SN5D are a form which can be used to furnish input data to us for calculation by the Computer Center at Louviers. Some plant people have said, "I want to run my own; let me have the information." Unfortunately, it isn't that easy. Most plants don't have the total facilities required to run the program. We are available and willing to help on evaluation work.

In summary,

- It is impractical and essentially impossible to provide you with just a single table of information for your site that will remain applicable. We have made tables for some sites, but the data are good for only a limited period of time. This is due to constantly changing labor and materials costs as well as the changing forces that may be doing the work.

- Whatever evaluations you make or have made for you, make sure all costs are included and that you are not just hitting the high spots and skipping some of the others because it isn't convenient.

- The item which I don't think I can overstress is maintenance. Regardless of how good a system looks on paper, if you don't maintain it, you have lost everything you spent -- and going back to increase thickness is not going to get you out of the hole. If you go back and close up the system you already have and keep it tight, I think you can solve most of your problems.

- Make sure you update whatever standards you are using. I know some of the plants are now starting to update while others are using thicknesses that go back into the 1960's. It is always easy to use what you already have; but for your sake as well as for all of us, I strongly recommend that you review your current practices and make sure they are performing as they were intended.

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SPRAYED POLYURETHANE FOAM SYSTEMS

L. L. Hash

I will describe for you this morning a study which we in the Repauno Technical Group conducted about a year and a half ago into the feasibility of using sprayed polyurethane foam systems for the insulation of heated storage tanks as a means of reducing steam consumption.

I will also describe some of the pitfalls we encountered so that others may learn from our experiences, and I will summarize the results to date of our study.

Our specific problem at the time involved the design of a new aniline storage tank which was to be heated by a steam bayonet. Our interest in sprayed insulation had been kindled gradually over the past two or three years as various magazine articles touted the many virtues of polyurethane foam, particularly the promise of up to 90% steam reduction in certain cases.

Our investigation quickly turned up several appealing features:

- K = 0.15

  This measure of heat transfer meant that:

  1 inch polyurethane foam = 1-3/4 inches glass fiber
  2 inches mineral fiber
  2-1/2 inches calcium silicate
  3 inches cellular glass

- This material has a density of 2 pounds per cubic foot versus 14 pounds per cubic foot for calcium silicate, our conventional material for tank insulation. This made foam particularly attractive as a covering for the roofs of large tanks.

- Since the foam could be sprayed directly onto the tank in liquid form, the claim of substantial labor savings seemed plausible: $1.25-$2.00 per square foot versus $3.00-$5.00 per square foot for conventional materials.

- Since a tank would be covered by a monolithic membrane, weather deterioration should be minimal.

- To satisfy our safety concerns, we reviewed the Engineering Standard Specifications and other guidelines with the Safety & Fire Protection Division and received their concurrence that the material could be used safely.

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Finding a 25% net return on investment (NROI) possibility with our original aniline tank, we quickly expanded our study to include all attractive candidate tanks on the plant. We established 20% as a minimum acceptable NROI.

At this time I should mention what may be one of the more important aspects of our study. A colleague, working with me, developed a computer program to easily, precisely, and rapidly calculate the monthly operating costs and savings potential for any tank, using various thicknesses of insulation. This program requires only 12 bits of data for any tank. We later disseminated this information throughout the Company for use by others. The program has been verified by comparing it to that of Owens-Corning, who have developed a similar program for contractors who use their materials. If any of you have waded through the laborious trial-and-error calculations in the DG Standards, I'm sure you can appreciate this labor-saving device!

We eventually found seven storage tanks that consumed appreciable amounts of steam. These tanks contained such diverse materials as aniline, benzene, nitrobenzene, 50% caustic, and No. 6 fuel oil. The calculated gross savings (possible) ranged from $5,000 to $100,000 per year per tank.

To complete the other half of our economic analysis, we prepared specifications for bids, with valuable assistance from George Lang and Roy Allen of ESD. We solicited bids from five contractors who seemed both knowledgeable and reputable. In order to choose the most economical thickness, we asked for quotations on 1-inch, 1-1/2-inch, and 2-inch insulation covered with a 30-mil coating of Hypalon® per our Engineering Standards.

When the bids had been tabulated, we found (Figure 1) that increasing the thickness from 1 inch to 1-1/2 inches resulted in an incremental cost increase of 11.7% with only a 2.2% increase in net savings. Similarly, increasing the thickness from 1-1/2 inches to 2 inches resulted in an incremental cost increase of 12.3% with only a 1.1% increase in net savings. We quickly concluded that 1 inch was the most economical thickness at that time, while savings exceeded costs even up to 1-1/2 inches for these particular tanks (Figure 2).

We had simultaneously prepared estimates to do the same work with plant forces. Our estimates showed a 30% higher cost. In addition, capital expenditures would have been required for specialized equipment to be used only a few times. However, the deciding factor was our uncertainty over the ability of our own people to match the skills of specialized contractors. We decided to concentrate on a contract job.

Following publication of our study, we ran into the major obstacle of 1975 -- the capital crunch. Despite the obvious attraction of a 100%+ NROI project, there was simply <u>no</u> money in the plant budget for new projects that did not meet the requirements of necessity, safety, or environmental regulation.

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TABULATION OF COSTS AND POTENTIAL SAVINGS PER YEAR, FOR VARIOUS THICKNESSES OF INSULATION

Insulation Thickness	Gross Annual Savings	Net* Annual Savings	Insulation Costs (Low Bidder)	Insulation Costs (Plant Forces)	Incremental Net Savings	Incremental Cost (Low Bidder)	Incremental Cost (Repauno Forces)
1"	$182,135	$87,425	$79,500	$103,000			
					$1,893 (2.2%)	$9,300 (11.7%)	$8,000 (7.8%)
1-1/2"	186,080	89,318	88,800	111,000			
					$1,015 (1.1%)	10,900 (12.3%)	8,000 (7.2%)
2"	188,193	90,333	99,700	119,000			

*Net = 48% x Gross

FIGURE 1

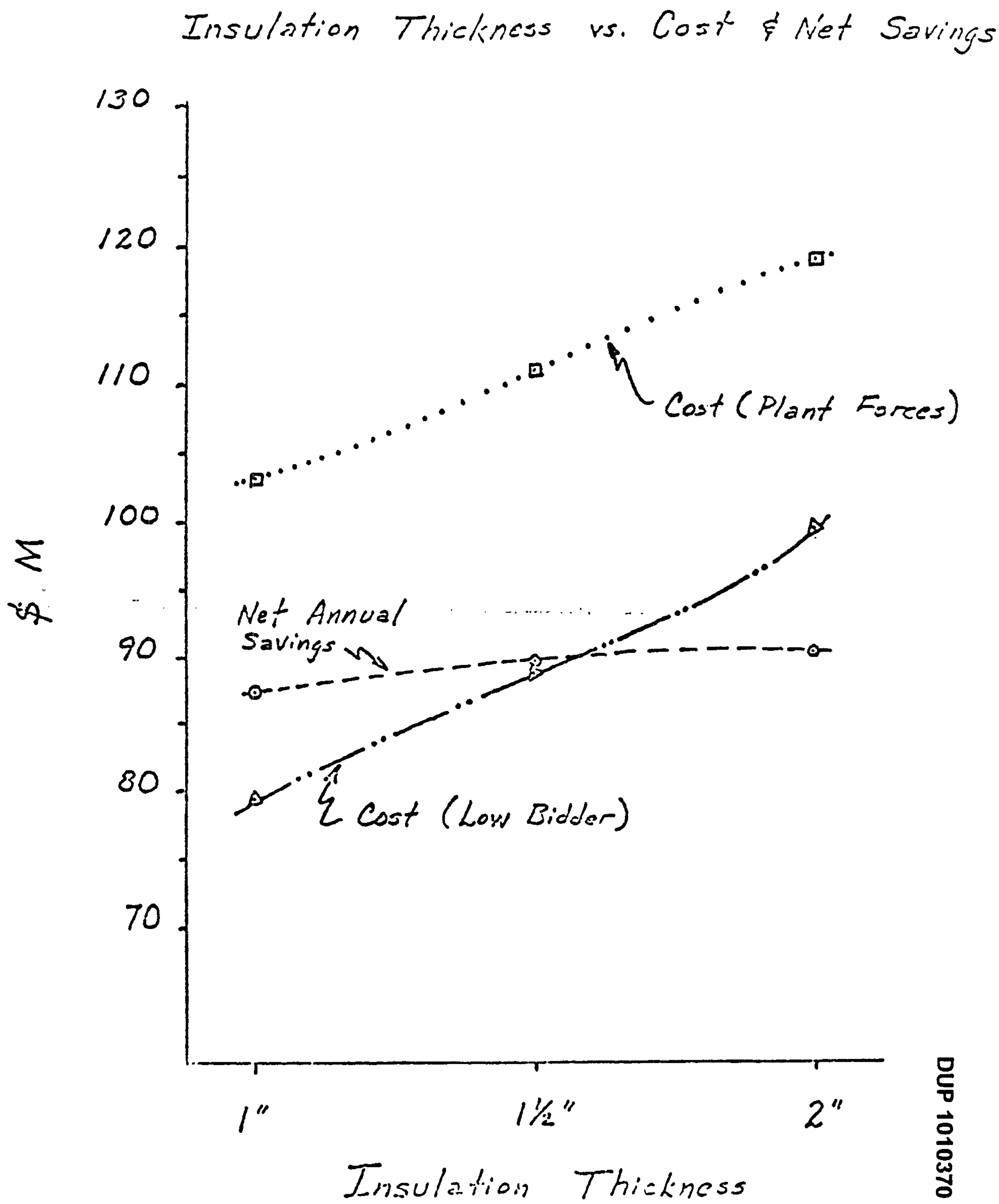

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FIGURE 2

We selected the most attractive tank (on the basis of net return) and made a presentation to ICD management in hopes of obtaining the necessary funds. Eventually we were given permission to go ahead on the promise of a $100,000 annual savings, based on a $30,000 project, for a net return of 170%.

We quickly asked the low bidder to update his quotation, which he happily increased from $21,000 to $25,000. This seemed reasonable, considering he was now quoting on one tank only, so we quickly prepared and got authorization for a $29,000 project.

I might interject here that this tank, our 2.2-million-gallon No. 6 fuel oil storage tank, had a coat of paint which was "chalky". It had reached the point where it was obviously in need of a new coat, but the primer was in good condition. We decided that sandblasting was not required to assure good adhesion by the foam. We elected to have the contractor clean the surface with steam and hot water to remove the "chalk".

Upon invitation to all bidders to update their quotations, we were surprised and chagrined (to put it mildly) when our low bidder boosted his price by an additional 58%, due to "an error in estimating"! Without pointing any accusing fingers, we were similarly surprised by the other four bidders who raised prices by like amounts! Needless to say, we had no bids within the authorized project amount. This left us in the unenviable position of having to ask management for a Part II before even spending the first dollar of the Part I!

While all the subsequent wailing and gnashing of teeth were in progress, who should save our skins but that ubiquitous sight around Du Pont locations, the traveling salesman! This fellow had heard about our job from one of the bidders and came calling to convince me of the superior virtues of his product -- a vinyl coating for foam insulation. After reviewing our proposed job, he promptly steered us to a contractor located out of the area -- a contractor who, coincidentally, was inclined to look favorably on this fellow's product.

To our pleasant surprise, however, this contractor did quote within our authorized limits -- using a 30-mil coating of vinyl instead of the Hypalon® specified. To assuage any doubts, he arranged a visit to the Exxon Bayway Refinery where he had insulated 700,000 square feet of tankage, including several with vinyl coatings. George Lang and Roy Allen, who accompanied us, concurred that the material was acceptable. While we estimated the coating would not have the longevity of Hypalon®, it would be suitable for a project with such a short pay-back as this one. Our trip to Bayway convinced us of the skill and workmanship of the contractor. In addition, he was held in very high regard by the Exxon Project Engineer.

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This bidder was quickly awarded the contract. Again, while we never doubted the sincerity of local contractors who were forced to raise their prices simultaneously, it was amusing to see their reactions when they learned they had been underbid by an outsider!

The job was completed November 1 with excellent workmanship. The project was closed within authorized limits. The final cost, incidentally, translated to $1.36 per square foot total installed cost. I emphasize (again) that this included only a steam/hot water cleaning -- no sandblasting or primer.

Although no instrumentation has yet been installed to document this cost reduction, we feel confident that the savings are being achieved. As evidence, we can offer only the fact that the steam supply valve was "barely cracked" (quoting our operating supervision) throughout most of the winter and was actually shut off up to a week at a time in milder periods. This compares to the past when the valve was left wide open year-round. There are also ample oil stains on the tank by now to indicate that the temperature frequently rose above normal limits and that oil vapors were carried out the vent.

As a corollary benefit, the tank was overdue for a $6,000 paint job, to which I alluded earlier. This, hopefully, has now been deferred for 10 to 15 years. Incidentally, this cost was not included in any of the aforementioned calculations.

Other plants have used this study for some rather interesting purposes and with some interesting results.

The Towanda Plant will realize a $40,000 gross annual savings on a $10,000 investment by insulating their oil storage tank. Because of a problem with the coating on their specified inch of insulation, their contractor recoated the tank with another inch of insulation. I was informed by the Plant Engineer that they had used practically "no steam" this past winter, despite "several -20° days"!

The Brevard Plant, I understand, has also completed an installation with an expected NROI of 260%.

The Wurtland Plant foamed the roof of an oleum tank for a rather unique and chilling reason. It seems that last winter the tank was found to have a 3-foot-thick, frozen SO_3 formation on the inside of the roof. To avert the possible collapse of the tank and spillage of 700,000 pounds of oleum, they completed the upper walls with conventional insulation and had the roof sprayed with urethane foam for weight considerations. Only safety aspects were involved there; no energy savings were computed.

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In summary, we believe that sprayed polyurethane foam systems offer one very attractive way to conserve energy through insulation of certain heated storage tanks. With the proper selection of materials; proper preparation of the tank surface; good advice from consultants, such as we had; and, most importantly, a good contractor, your installation undoubtedly will be a success.

THERMAL INSULATION MAINTENANCE

J. R. Allen

Efforts under the Protective Coatings Program spanning many years ultimately led to a sophisticated approach to industrial plant maintenance painting unmatched in the field. Successful application in Du Pont served as the basis for the development of the F&F Department Maintenance Painting Service. Later in the program you will hear more about the success and current status of this new venture.

From a long-range standpoint, we had learned from experience that for protective painting of steel it was more economical to apply the principles of preventive maintenance rather than allowing such painting to proceed to extensive failure requiring complete surface preparation and repainting. Complete paint failure is visually obvious and requires little skill to detect. Too often this was the guideline used to schedule maintenance painting. Seldom was much earlier consideration given to "when is the most economical time to paint".

We developed a system for judging and rating the condition or degree of failure of paint on steel. Experience had indicated and continues to confirm that generally for economic painting, maintenance should be scheduled before failure exceeds a rating of II on this scale. As this condition is exceeded, repainting costs rise rapidly in most cases. A Condition V is a 100% repaint job and will be a 100% repaint job if delayed. Therefore, in planning maintenance painting, Condition II should be assigned higher priority than Condition V. Naturally this cannot be practiced to the exclusion of painting Condition V. At least a significant portion of the painting budget should be devoted to Conditions II and III.

For long-range planning, a system and procedures for plant surveys were developed. This included dividing the facility into practical painting packages; defining current paint condition in accordance with the rating system; and, by applying the principles just reviewed, judging the proper time to paint; and, lastly, with the assistance of professional estimator, providing an estimate of man-hours' labor for proper painting. Normally painting and repainting are scheduled to span a ten-year period. A summary of such a survey provides a planned ten-year maintenance painting program including recommended specifications and estimated cost.

Most of us, I think, would agree that thermal insulation maintenance, at least in many cases, is often inadequate and sometimes lacking. In view of energy costs and shortages, insulation and insulation maintenance has become more important and is receiving more attention.

About a year ago Materials Engineering management decided that if the survey and program approach to maintenance painting could be developed and made to work, then why shouldn't we be able to do the same for thermal insulation maintenance?

It has been a challenging struggle; it is not fully perfected nor complete. At this time I would like to review for you our efforts and current status.

With the experience and success in painting, we naturally patterned this approach after the Maintenance Painting Survey practices where they were applicable and otherwise adjusted or developed procedures to cover the unique problems associated with thermal insulation.

As a minimum for what a thermal insulation maintenance survey should accomplish, I offer this. It must answer and communicate:

- What is the existing condition?
- When should repairs be made?
- Which materials should be used for repair?

To achieve this, I have outlined objectives of the survey, one being rather challenging, as a guide for its execution.

The following is a list of those objectives which we used as a basis for developing survey work sheets. To conduct a survey that will produce meaningful results, we must:

1. Divide into and identify practical maintenance packages.
2. Define service, insulation system, and current condition.
3. Establish maintenance priority and schedule.
4. Outline recommended repair.
5. Estimate man-days' labor required.

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For some of these we felt, through experience, capable of handling them; for others, further study and planning was necessary. The latter includes the last part of item 2, defining current condition; item 3, establishing maintenance priority and schedule; and item 5, estimating man-days' labor.

(FIGURE 1) For defining current condition, we developed a system for rating the condition of thermal insulation systems. It is designed to allow for the application of preventive maintenance principles in scheduling repair. I should also point out that the objectives of this survey approach are aimed at the functional condition of thermal insulation and do not attempt to cover appearance. Water is a major enemy of the function of thermal insulation. Therefore, one underlying theme of this rating system is closely related to whether the insulation is wet or in such a condition and exposure that it soon will be. A Rating I says the insulation system is functionally in good condition and needs no repair. Rating II indicates defects in the system but not such that the insulation is likely to become wet. Rating III is the same except that exposure and defects are such that the system is very vulnerable to becoming wet. The last, Rating IV, indicates that the insulation is wet or otherwise deteriorated, therefore not very functional.

SYSTEM FOR RATING CONDITION OF THERMAL INSULATION SYSTEMS

Rating	Description
I	Dry and in good condition. Finish and fasteners functional to keep out mois ure.
II	Breaks in finish but in a location not vulnerable to moisture entry or deteriorated flashing not in a critical location.
III	Breaks in finish or deteriorated flashing vulnerable to moisture entry.
IV	Wet or otherwise deteriorated basic insulation.

FIGURE 1

This system is significantly different from that for paint in which the rating indicated percent of failure. This rating defines only the nature of defect or failure. Therefore, along with the rating, we add a number that is our estimate of the percent of the insulation system in the condition defined. For example, "II10" would mean that 10% is in Condition II, the remainder is in good condition; thus I. You can see that in some cases this might lead to a double rating, but meaningful and informative.

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The next problem was how do we establish maintenance priority and schedule? In other words, how do we decide when repairs should be made? My experience suggests that, to say it briefly, one must have a lot of nerve and exercise good judgment.

I have assembled some of the factors to be considered in making this decision. Naturally, if the condition or lack of insulation creates a safety hazard, it receives high priority for maintenance. Operation requirements must be considered. If adequate process control is threatened, this dictates high priority. Economics is always a consideration. Do the result and the return justify the expenditure? For example, if we had defective insulation in a noncritical situation and the insulation repair would cost $100 but would require $1,000 worth of rigging, we would delay this hoping to coordinate it with other maintenance requiring similar rigging. And, of course, energy costs plan an important part in the economic consideration.

If we have deteriorated insulation, the exposure and the degree and nature of the defects influence scheduling. An insulated hot line in a dry indoor area is not in critical need of repair if there are a few breaks in the finish or flashing. The same condition outdoors could get wet during rains, result in high energy losses, corrosion of the metal, and rapid deterioration of the system. This situation justifies high priority for maintenance.

Cause of failure can influence recommending and scheduling repair. If it is due to frequent and excessive abuse, repair might be questionable because the repaired system soon would be back in the same condition. If it is necessary to coordinate with other crafts or desirable to do the work during scheduled shutdowns, these can influence priority. If corrosion is threatening failure of the metal substrate, this justifies high priority.

The last problem in our list of survey objectives was and still is that of estimating man-days of labor required for the defined maintenance. This is a difficult but a very desirable part of the survey. Help on this effort is required from insulation foremen, superintendents, supervisors, and contractors.

(FIGURE 2) One final requirement is a survey work sheet. This was prepared to cover the five survey objectives:

- Identification
- Description of Service, Insulation System, and Condition
- Schedule for Maintenance
- Materials for Maintenance
- Estimated Labor

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Page____
Date____

THERMAL INSULATION MAINTENANCE SURVEY

PLANT____________ AREA____________
BLDG. OR UNIT____________ SECTION____________
GROUP____________ ITEM____________

DESCRIPTION:
Service: Indoors Outdoors Temp.,°F________
Abuse: L M H Environment________
Substrate: S SS Other________
Insulation System:____________________

Current Condition:____________________

SCHEDULE FOR MAINTENANCE: /76 /77 /78 /79 /80
EST.CONDITION AT TIME OF REC.REPAIR____________

REC. MAINTENANCE: Repair Replace
Insulation____________________

Fasteners____________________

Finish____________________

ACCESSIBILITY____________________
EST. MAN-DAYS LABOR____________________
REMARKS____________________

FIGURE 2

At this point I decided that we had spent enough time on this endeavor from behind a desk and that it was time to put it to a small-scale test. Lee Jennings at Chambers Works, who has worked with me in the past on painting surveys, offered a multitude of candidate examples for trial and agreed to participate in a trial surgey. Naturally our selection was not too large nor too complex. It was at Chambers Works, Building 72, Crude Chlorinator. We surveyed it, and this was accomplished by completing five work sheets without many blank spaces being left.

- Identification:

PLANT:	Chambers Works
AREA:	Intermediates West
UNIT:	Pipe Bridge
SECTION:	4 bays from northeast corner Building 72 south 75 feet
GROUP:	insulated pipe
ITEM:	two steam lines

- Description:

  Service: outdoors; operating temperature 365°F; abuse is medium; environment involves process handling chlorine, caustic, and hydrochloric acid; substrate is steel.

  Insulation System: consists of double layer calcium silicate, 4 inches thick, covered with roofing felt secured with staples and wire.

  Current Condition: judged as 10% III and 5% II in accordance with our rating scale.

- Maintenance Schedule:

  For this condition, which results in wet insulation during rains, maintenance is recommended during the first half of 1976. By that time we estimate no change in condition.

- Maintenance Recommended:

  Repair, using calcium silicate insulation, wire and staples, and roofing felt.

- And, lastly, units are accessible with a 20-foot ladder, and we estimate two man-days' labor.

This mini-survey is summarized in FIGURE 3 and covers identification of item, current condition, and recommended maintenance schedule. This schedules one-time maintenance for all insulated items in this package. In time we may add an estimate of repeat maintenance.

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SUMMARY OF INSULATION SURVEY

PLANT: CHAMBERS WORKS DEPT.: ORCHEM AREA: INTERMEDIATES WEST						
IDENTIFICATION	CONDITION	MAINTENANCE SCHEDULE				
		1976	1977	1978	1979	1980
1. Bldg. #72 Crude Chlorinator						
A. Indoors						
1. Pipe						
a. Process & Steam, 140°-300°F	II 15				X	
2. Equipment						
a. Tank T3, 140°F	II 20			X		
b. Separator SP-1, 140°F	I			X		
B. Outdoors						
1. Pipe						
a. Process & Steam, 140°-300°F	III 30	X				
2. Equipment						
a. Catch Tank, TC-4	III 5	X				
2. Pipe Bridge						
A. From N.E. corner Bldg.72 to 4 bays South, 75 ft.						
1. Pipe						
a. Two steam pipes, 8"-10", 365°F	III 10, II 5	X				

FIGURE 3

Len Perry recently provided a dramatic example of the importance of insulation maintenance. The Parlin Photo Products Plant noticed a 165,000-pound-per-day increase in steam consumption from one day to the next. The ambient temperature and plant operating conditions were the same on both days -- but on the first day the weather was clear and on the next it rained all day. Inspection revealed extensive deterioration of the roofing felt finish, especially on the top of steam header lines -- thus, wet insulation when it rained. Aluminum jacketing has been installed to preserve the insulation and eliminate this excessive energy loss.

We are ready for a real test of the survey approach assembled thus far. We solicit candidates and hope to find a modest-sized area that includes hot and cold pipe and hot and cold equipment, both indoors and outdoors. This survey will be financed by the Thermal Insulation Program which is sponsored by the operating departments and Engineering. If this proves successful, surveys will be offered as a service.

CORROSION OF STEEL UNDER INSULATION: CURRENT PROBLEMS

W. I. Pollock

Carbon Steel

The corrosion of carbon steel under thermal insulation is not a new problem. At the October, 1970, Company Protective Coatings & Thermal Insulation Meeting held in Circleville, Ohio, Martin Hennessey of PID reviewed problems on the Victoria Plant. Hennessey pointed out that corrosion under insulation has been a continuing problem. In one example given, pits in a nozzle were so deep that less than 1/16 inch of metal remained.

Hennessey made several key observations and conclusions:

- Insulation on certain lines is continuously wet.
- Certain carbon steel vessels and tanks which were primed (with Corlar® Zinc Chromate) prior to being insulated have presented no corrosion problems. The cost of sand-blasting and priming is about 2% of the total cost of insulating.
- If it were possible to maintain insulation in such a way that vapor seals and weather seals were kept intact, then it would be economical not to prime prior to insulating carbon steel.
- Very few plants have the manpower to devote to maintaining insulation to the high degree required for maximum protection. An alternate is to protect the metal surface prior to insulating.

I am using Hennessey's report to set the stage for observations made last year of severe corrosion problems of carbon steel pipe under calcium silicate insulation on two plant sites that are widely separated geographically. What happened was:

- At Old Hickory, preinsulated pipe stored outdoors got wet from unusually heavy rain conditions and remained wet for an extended period of time.
- At Sabine, the application of insulation on an outside overhead line was in progress; and before all joints and open ends were properly sealed, a work stoppage delayed the work for an extended period of time, and the insulation got wet and remained wet.

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Bailey Mundy, Construction Division, and Bill Rion, ESD-CRO, have investigated the Old Hickory problem in great detail. They found that the corrosion started on the electric resistance welded (ERW) pipe surface in the presence of the wet insulation at a place where the blue oxide film, which results from the thermal treatment of the pipe, is scratched or broken down. Standard Engineering Specification SW2F specifies this finish for rust prevention during shipment and storage.

Corrosion and pitting occurred in small, irregular areas on longitudinal sections of pipe as well as bends and varied in size from pencil eraser up to half dollar. The corroded areas tended to form an elongated linear shape running the same direction as the pipe.

The corrosion mechanism proposed for this problem is formation of galvanic cells where a potential difference exists between two dissimilar metals when immersed in a conductive solution. In this case the unprotected portion of the pipe becomes the anode to the oxide film portion which acts as the cathode and corrosion of the unprotected area occurs.

An important observation made was that the corroded areas were seemingly more frequent at pressure points under the tie wire which holds the insulation in place and at supports used in storage.

Corrosion depths were as great as 0.095 inch, with the norm being around 0.030 to 0.040 inch.

Although efforts were made to lay the pipe in such a manner that the lap of the aluminum jacket would shed water and to wrap the insulated ends with polyethylene wired or taped to prevent water from entering from the outside, Mundy noted that the laps were not always positioned during outdoor storage in the best possible manner to shed water or even that they could be positioned properly due to the spaghetti shapes of many fabrications.

At the Sabine River Works, M. A. Streicher, ESD Materials Engineering, and J. L. Gossett, ESD-GRO, examined many samples of corrosion under insulation. Streicher's conclusion was that the pitting observed was a result of crevice corrosion caused by wet insulation. Crevices formed where the insulation was in close contact with the steel surface; i.e., is squeezed against the surface.

The oxidation and reduction equations for metal corrosion are shown in Figure 1. The role of oxygen in enabling a corrosion reaction to occur forms the basis for the fact that oxygen can promote a cathodic reaction. This occurs where there is a difference in the concentration of dissolved oxygen at one point on a metal surface as compared to another point.

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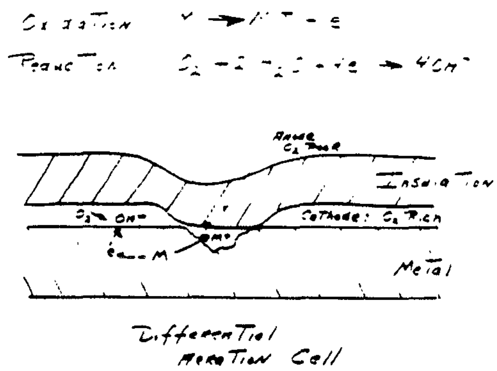

FIGURE 1

There will be a rather general rusting of the surface of the pipe. In this process oxygen is consumed. Because replenishment of oxygen by diffusion into the crevice is impeded or prevented, a differential aeration cell is established between the oxygen-poor surface in the crevice and the much larger oxygen-rich surface surrounding the crevice. The surfaces exposed to the lower oxygen concentration will suffer accelerated corrosion as anodes in this cell.

The "best" crevices, Streicher reported, were formed where the insulation was most severely pressed against the steel surface; e.g., by its own weight at the top of the horizontal pipes or where the wire pressed the insulation against the steel.

The most likely source of water in the insulation, Streicher postulated, was from rain either directly on the insulation during installation in the field before it was covered with aluminum sheet and/or by seepage through means of the aluminum covering during storage before start-up.

Detailed inspections (as of February 13, 1976) revealed:

	Old Hickory	Sabine
Isos Inspected	2,600	152 (200 + req.insp.)
% Wet	6	34
% Corroded	1.5	30 (46 lines)
Exposure Time	8-13 mos.	8-14 mos.

Only two pieces of pipe at Old Hickory actually required replacement. At Sabine, after about 90% complete inspection, eight lines needed repair.

At this time we do not have full explanations for the magnitude of the problems at Old Hickory and Sabine. Hennessey suggested that the location of the Victoria Plant near the Gulf Coast is partly the cause of the corrosion under insulation problem at this site. Sabine, also, is near the Gulf Coast, but Old Hickory is not.

The piping was wet for quite long periods of time at ambient temperatures, and this must be a prime factor.

Recent changes in insulation with the Company's use of asbestos-free calcium silicate may be a contributing factor, but we have no experimental data or plant experiences to verify this. "Pink" insulation is not believed to be a factor; color was added at one time to identify vendor and type.

The ESD Materials Engineering Group and the Engineering Test Center have initiated studies to obtain more information on this problem:

- J. C. Bovankovich, ESD-ETC, is evaluating an electro-chemical test technique for measuring galvanic potentials and currents between heat treated ERW pipe with a blue color and unheat treated pipe. The objective is to assist in verifying the mechanism of corrosion of carbon steel pipe underneath wet insulation.

- W. E. Ellis, ESD-Materials Engineering, and R. N. McCormick, ESD-ETC, are attempting to accelerate the corrosion of carbon steel under wet insulation by raising the temperature to 125°F of a steel "U" bend sample using an ASTM wick test set-up for insulation. Samples with a blue oxide surface, with an "X" scratched through the oxide, and with no oxide surface are being tested to simulate field observations. The insulations being tested are:

    - Thermasil-Asbestos Free - Industrial Insulation Division of Keene Corporation

    - Super Caltemp, Type NA - Fiberboard Corporation (PABCO)

    - Thermo-12 - Johns-Manville

    - Kaylo-10AF - Owens-Corning

    - Unibestos - Pittsburgh-Corning

- G. E. Lang, ESD-Materials Engineering, with W. C. Rion, Jr., is testing insulated pipe samples partly immersed in tap water at room temperature. Samples of EWR pipe with the blue coating intact and with an "X" scratched through it are being tested. Also, plain carbon steel pipe as received with

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one coat of Dulux® Zinc Chromate, and plain carbon steel with bright sandblast only are included. The insulations are: Thermasil-Asbestos Free, Super Caltemp Type NA, Thermo-12, and Kaylo-10AF. The experimental set-up insures there will be a controlled crevice condition for each pipe sample. Examinations will be made at 3, 6, 9, and 12 months for pitting corrosion.

To date, none of these studies has progressed to where significant conclusions can be drawn.

Probably regardless of the mechanism of corrosion, types of insulation, and surface conditions, there are only two basic solutions to effectively control serious corrosion problems resulting from wet insulation on pipe:

- Keep the insulation dry.
- Paint the carbon steel before application of insulation.

Since the period of time insulation is wet is a key factor, keeping this period "short" would eliminate serious corrosion problems.

The Engineering Department Thermal Insulation Subcommittee recently has examined the problem of keeping insulation dry and recommended the following:

- Do not store preinsulated items outdoors without adequate precautions to prevent moisture from entering the system. When preinsulated items are stored outdoors, they must be placed on suitable supports of sufficient heights to keep them above possible flooding during heavy rains.
- In the event that a project delay appears likely, all in-progress insulation work should be physically checked to make sure that all points of possible moisture penetration are adequately sealed before work is halted.

Even with these precautions, some insulation will get wet. Recognizing this, the Subcommittee has recommended:

- Do not apply finish or jacket over wet insulation. If insulation can be dried out by passing steam through the insulated system, air drying or similar means, it is permissible to do so. If this is not practical, then the wet insulation should be removed and replaced with dry materials.
- And, if removing the wet insulation and replacing with dry material is not practical or economical, or both, a second solution is possible -- paint before application of insulation.

The cost of prime coatings is always a factor to consider in any pipe insulation job. For 4-inch-diameter nonfabricated pipe, $0.41/foot, we believe, is the lowest price for blast cleaning to a commercial finish plus 2-1/2 mils of inorganic zinc (Ganicin®) in a shop; and this price might be as high as $1, depending on location and certain competitive factors.

J. R. Allen, ESD-Materials Engineering, questions whether this ysstem is needed for the function desired; that is, to retard the start of crevice corrosion under wet insulation. Probably hand cleaning or brush-off blasting plus Dulux® zinc chromate primer, an alkyd, would be satisfactory. Cost should range from possibly as low as $0.20/foot to $0.70/foot for 4-inch-diameter pipe. This system is being tested in one of the pitting studies mentioned earlier.

Corlar® zinc chromate primer (which Hennessey stated gave good results at Victoria) should be applied on a sandblasted surface. If blasting is required, we would have no savings in metal surface preparation compared to the inorganic zinc -- but the difference in primer costs can be substantial.

M. B. Harkins, Design Division, collected some cost information which is useful in making rough comparisons:

Cost of Painting Pipe

One Wilmington Contractor's Rough Estimate
(Includes Materials & Labor)

April 1976

	Shop	Erected in Field
Hand Blast to Commercial Finish	45-55¢/ft	60¢-$1/ft
Hand Brush Blast	25-35¢/ft	40-60¢/ft
Hand Clean	20¢/ft	25-35¢/ft
Inorganic Zinc (Ganicin®) Primer, 3 mils	50¢/ft	60-90¢/ft
Epoxy Zinc Chromate (Corlar®) Primer, 2 mils	30¢/ft	40-60¢/ft
Alkyd Zinc Chromate (Dulux®) Primer, 1-1/2 mils	20¢/ft	25-40¢/ft

A purpose of the primer is to provide protection prior to start-up. Another is protection after start-up and during operation. There is much experience in the Company of painting under insulation of piping and storage tanks operating at ambient or below temperatures. K. V. Martin reported at the 1964 Annual Company Protective Coatings (and Thermal Insulation) Meeting that the Belle Plant has had this painting practice since 1963.

If protection is required above ambient temperature, then the performance of the primer or paint at operating temperatures must be taken into account. As a guide, the recommendations for maximum temperature for continuous operation that would not significantly diminish protection are:

Dulux® Zinc Chromate	200°F
Corlar® Zinc Chromate	250°F
Inorganic Zinc	600°F

(For applications above about 650°F on stainless steels, zinc-bearing paints should not be used because of embrittlement problems.)

Handling may cause scratches and other surface defects, and hand touch-up may be done; but this is not usually required unless large metal surface areas are unprotected.

Stainless Steel

Austenitic stainless steel at or above 140°F in the presence of wet chlorides are subject to an insidious problem -- stress-corrosion cracking (SCC). The 300 series stainless steels, such as 304, 304L, 316, and 316L, are austenitic grades.

Studies in the 1950's by the Engineering Department indicated that all of the commonly used insulating materials (studied at that time) contained significant amounts of readily leachable chlorides. As a result of this work, the sodium silicate-inhibited asbestos-fiber type insulation was identified that could be used safely on the austenitic stainless steels.

Sodium silicate solved two problems: First, it inhibited the chlorides that were present in the insulating material; and, second -- of significant importance -- it also inhibited chlorides from external sources such as industrial and marine atmospheres. Insulation traps the chlorides and concentrates them to a level where SCC could take place.

Since late 1963, Du Pont standard practice has been to use only those insulating materials which contain a satisfactory quantity of an inhibitor -- even if the insulation has a low chloride content. Since sodium silicate is also a binder for asbestos, many manufacturers used this chemical in manufacturing some of their process insulation grades.

Du Pont's use of asbestos fiber with sodium silicate binder goes back to about 1961. Reviewing stress-corrosion investigations in the thermal insulation field in March, 1965, W. C. Rion, Jr., reported that no field failures have occurred with this type of insulation; and it is believed no field failures ever occurred in Du Pont with this type of material when properly maintained.

With the passing of the Occupational Safety & Health Act (OSHA) in April, 1971, Du Pont's policy is to use asbestos-free process insulations wherever there is a suitable substitute for asbestos fiber. Except for two products, "A" cloth and Marinite board, this is being done at all of our sites. G. E. Lang has had a key role in this effort under our Company Materials Engineering Programs and continues to identify new asbestos-free materials and thermal insulation systems and to evaluate them as they are offered on the market.

Asbestos-free calcium silicate generally is the approved replacement for asbestos-fiber-bearing calcium silicate. At the beginning of this year there were only two nationally distributed brands of calcium silicate-inhibited insulation approved by the Process Thermal Insulation Standards Subcommittee for Code 102.1 category:

- Thermasil-Asbestos Free (Keene)
- Super Caltemp, Type NA (PABCO)

Manufacturers increasingly desire not to manufacture the inhibited product. Recently Keene announced that they no longer manufacture Thermasil. We now are left with one national supplier.

Du Pont has had failures with uninhibited calcium silicate under conditions that vary widely. Rion (in 1965) reported that there were at least ten, most of them after 1958. One failure, Rion states, occurred during storage of an insulated equipment item prior to installation in a new plant. Interestingly, only clean rainwater is believed to have entered the insulation.

Over the years, we have had SCC failures of austenitic stainless steel items under wet insulation believed in many cases to have been inhibited. Recently some surface cracking was observed on stainless steel equipment at Sabine which had been in operation for 20+ years.

If inhibited insulation gets wet, the inhibitor can be washed -- leached -- out. Recently G. E. Lang and W. E. Ellis have carried out some tests to obtain more information in this area. They found that with Super Caltemp NA about 70% wet with chloride-bearing water, some "U" samples developed cracks. These studies demonstrate that continual wetting with chloride-bearing water of inhibited insulation on austenitic stainless steels presents a serious SCC problem.

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One start-up with damp insulation should not cause cracking of stainless equipment and piping operating above about 140°F since that portion of the insulation adjacent to the metal will become dried out. But, if the inhibitor is sufficiently leached out and if the metal surface temperature fluctuates to about ambient -- and this could readily happen as a result of maintenance shutdowns or operating difficulties -- or if the equipment is put into temporary storage from time to time, then the concentration of chlorides at the metal surface could increase to where SCC could occur at operating temperature. This problem would be accelerated if chlorides were introduced to the insulation from external sources after start-up.

Du Pont's decade-plus policy of using only inhibited insulation for austenitic stainless steel items at or above 140°F is not practiced by many other companies. Union Carbide, Chemical & Plastics Division, and Monsanto report they use uninhibited brands and prior to insulation:

- hand clean to remove dirt and grease (although sandblasting is sometimes done), and
- paint with Thermalux #70, a carbon-filled silicone coating.

The carbon addition permits use of Thermalux #70 with some protection up to about 600°F.

One of the main problems with any protective coating is pinholes and scratches from handling and storage. Union Carbide, an initiator of this painting practice in the early 1960's for their Gulf Coast plant sites, recognizes the potential pinhole problem with a single coating and, therefore, specifies two coatings.

The number of through-film pinholes after two-coating applications, Union Carbide states, is "small enough to not have to worry about from an engineering standpoint". Monsanto also recognizes the potential pinhole problem with only one coat but states that applying two coats is not their practice. Both companies state they touch up scratches and damaged areas if required.

With the availability of inhibited thermal insulation, Du Pont's position has been that the protectiveness afforded by coatings such as Thermalux #70 does not justify the cost. But, if we do not maintain the inhibited insulation in a dry condition, then painting with a protective coating has some merit.

If uninhibited insulation has to be used, Du Pont Standard SN102.1D gives a protective coating practice. Recommended is sodium silicate, 40 Bé, at less than 100 square feet per gallon. Since this chemical is somewhat water soluble, it has a self-sealing and healing tendency for scratches. Also, it provides protection up to about 900°F.

Ad Hoc Committee

An ad hoc committee has been formed within the Engineering Department to review the situation of corrosion of piping and equipment under insulation for possible Company-wide implications. The first objective of the committee is to determine if this problem is widespread and, if so, to recommend appropriate remedial measures. Corrective measures will have to be based on consideration of the number of failures observed compared with the cost of minimizing corrosion of carbon steel or chloride stress-corrosion cracking of austenitic stainless steel.

A questionnaire is being drafted to survey industrial department experiences.

Summary

The question which may be asked, especially by plant maintenance personnel, is: What will happen if one does not replace wet insulation on steel or dry it or prime the metal prior to insulation? The answer, at this point in time, is that one might have a serious corrosion problem, but we cannot define criteria such as how long wet insulation can remain on steel and under what conditions before serious corrosion problems take place. Studies currently in progress should be helpful in defining guidelines.

I have not discussed the thermal efficiency loss when insulation gets wet. We base our insulation thickness on dry, laboratory test conditions; and "K" factors are markedly affected by moisture.

With the loss of the thermal insulation function comes a decrease in energy conservation; and, frequently, the wet insulation affects the required process operations. There is more to be lost through wet insulation sometimes than just the pipe.

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PAINTING DRIP COOLERS AND CHLORINE HEADERS

M. F. Hennessey

The Victoria Plant is a part of the Polymer Intermediates Department producing nylon intermediates, including nitric acid, hydrochloric acid, sodium cyanide, adipic acid, and hexamethylene diamine. We also produce Alathon® (polyethylene) and chlorobutadiene for neoprene. Our plant is near the Gulf Coast between Houston and Corpus Christi, Texas. We have about 1,350 employees on the Plant. The Plant started operations in 1951, and we are celebrating our silver anniversary this year.

My first subject is our experience at Victoria with controlling corrosion on recycle discharge drip coolers used in our Alathon® process. Basically the problem has been corrosion promoted by cooling tower water during a search for environmentally acceptable water treatment systems. During a period of about a year, we saw more severe corrosion than in the previous 14 years. These tubes originally were metallized with aluminum and seal coated with Metco Silicone Aluminum Seal Coat. This system had been satisfactory until Operations decided to acid clean the coolers because of the carbonate build-up caused by inadequate water treatment. Following this, corrosion proceeded at the rate of 40 mils per year for approximately six months. At this rate there was only about six months' service life remaining in the recycle discharge drip coolers. Our choice at this time was to replace the coolers at a cost of approximately $100,000 or stop the corrosion. In order to stop corrosion, we decided to change the water treatment and take the coolers out and sandblast to white metal, prime with 947-931 Ganicin® Inorganic Zinc, followed with 825-8031 Corlar® Zinc Chromate Primer and two coats of Imron®. Imron® was used because we felt it would provide a slick surface and make carbonate build-up easier to remove. We also felt that, although the Imron® might not stand up in this service, we still would have adequate protection on the metal. At the end of one year's operation, this coating is still protecting against corrosion. The Imron® is stained in places but is still intact. At some places it has blistered, but the blisters are in the top coats only; they do not penetrate the primers or go to the metal. Carbonate build-up has been negligible on the tube bends and very little on the straight runs.

One year ago when we decided to try this system, a two-year coating life was considered to be a satisfactory, economic life span. Other tests indicate that this can be lengthened by using 347-931 Ganicin® Inorganic Zinc followed by one coat of High-Build Corlar®.

My second topic is chlorine headers.

Two years ago, following several chlorine leaks which were caused by externally initiated corrosion, management became concerned. We launched a painting program for chlorine process equipment and piping which is now a Victoria Plant standard. This requires sandblasting to Class II surface, priming with Du Pont 347-931 Ganicin® Inorganic Zinc followed by one coat of Du Pont 823-3081 Corlar® High-Build Gray and top coated with Shale Gray Imron® Polyurethane Enamel. This has proven to be a good system, and we have had no external corrosion problems where this system was used. We have three chlorine vaporizers where this system has been in use for more than five years.

FIELD PANEL TEST RESULTS

R. N. Mc Cormick

Field panel testing is an important part of the Company's Protective Coatings Program. The results from these tests provide us with information to be used in standards for specifying coating systems for many different environments. The tests are also important to the F&F Department, Maintenance Finishes Division, because they are afforded an opportunity to test new paint formulations under field conditions and evaluate them quickly without excessive investment.

Today I shall report on results of exposures at the Corpus Christi and East Chicago sites.

The Corpus Christi exposures were made in January, 1974. They are about 100 feet from the water and provide information on performance of coating systems exposed to salt air as well as other chemicals in this area.

Our field panel tests are rated numerically as follows:

10 = No change

8 = Condition requiring spot cleaning and touch-up

6 = Paint system failure; complete cleaning and repainting required

Table I shows the data sheet used to record the information required to evaluate each coating system. Two examples are shown in this table.

Table II shows the results of different primers over exposed hand-cleaned carbon steel. Dulux® metal protective paint was used as a topcoat for all systems. All systems failed in two years, the best system being system number 1. Water washing prior to painting helps performance somewhat in this environment.

Table III shows a variety of primers and topcoats along with one system employing a surface treatment prior to priming and topcoating. Generally, better performance was realized over unexposed hand-cleaned steel than the exposed steel systems shown in Table II.

The surface pretreatment, VQ penetrant, system did not perform as well as the identical system with no pretreatment.

Table IV shows the results of zinc-rich primer over unexposed, blast-cleaned carbon steel. While most of these systems performed well, Du Pont organic zinc primer and Dimetcote EZ zinc did not. The vinyl-topcoated systems are performing very well.

Table V shows the effect of surface profile on primer performance. While it may still be too early to arrive at a firm conclusion, it appears that a 1-mil surface profile is adequate and a 3-mil surface profile may be more than needed.

Table VI is a compilation of data using different primers with 369 Line High Build Imron®. The F&F experimental oligomer resin primer A05, has failed because of no resistance to underfilm corrosion at the cuts. The other systems are performing well after one year.

Experimental work was done using high-pressure water with abrasive at the Partek plant in Houston, Texas, in the fall of 1974. The steel surfaces were prepared by three methods:

1. high-pressure water (6,000 lbs) with abrasive
2. high-pressure water (6,000 lbs) with abrasive and inhibitor
3. ordinary blast cleaning

All surfaces were cleaned to white metal, Class I. The steel panels were allowed to remain 4 and 24 hours before topcoating. Three different primers were employed, but the topcoat was the same in all systems.

Table VII shows the results of those panels that went 24 hours after cleaning and before priming. The Ganicin® IOZ is performing well regardless of surface preparation at the end of one year.

The East Chicago exposures were made in the fall of 1974. This plant has some highly corrosive chemicals in use, so we thought here was a place to get quick results -- and quick results we got. After only one year's exposure, we have a number of failures.

Table VIII shows performance of systems over exposed hand-cleaned steel. Here, again, the surface pretreatment of VQ penetrant did not perform any better than the identical system without it.

Table IX represents a few of the better performing systems at this site. As you can see, the Cadillac system of IOZ, Corlar® H.B., and Imron® is doing well along with the Imlar® vinyl topcoated systems.

In conclusion, our work with high-pressure water and abrasive is continuing to see if the formation of bloom rust is a detriment to paint performance.

Our tests indicate that, again as in the past, surface pretreatments are not justified because of poor performance and early failure.

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The Cadillac system of IOZ, Corlar® H.B., and Imron® is doing well at all test sites.

Imlar® vinyl will provide excellent protection to steel when applied over a good primer, such as Ganicin® and to a proper DFT, which we believe to be 3 to 4 mils per coat.

TABLE I

DUP 1010396

PROTECTIVE COATINGS FIELD PANEL TEST

Site Corpus Christi
Location Texas
Date Exposed 10/14/74

Exposure Conditions:
Salt air - Wind - Sunshine
Fumes - Cl - HCl - High Humidity

Corrosion Rate, MPY:
Steel 1.76
Galvanized Steel .15
Aluminum 0.074
Cor-ten 1.52

PANEL RECORD						EXPOSURE YEARS & PERFORMANCE RATING									
#	S	PC	SP	Coating System	DFT		1 yr	2	3	4	5	6	7	8	9 yrs
150	CS	U	SB I	Ganicin® - 347-931 Imron ®- 326y67646 Imron ®- 326y67646	5/6	T	9.6	9.3							
						E	10	9							
						C	9	9							
						F	10	10							
50	CS	U	SB II	67-746 Dulux ® Primer 823-64633 Corlar® I. Mix Tank White 823-64633 " " " " "		T	8.9	7.8	6.5	5.3*					
						E	8.5	7	5.5	4.5					
						C	8.3	7.3	5.3	3					
						F	10	9.1	8.8	8.3					
						T									
						E									
						C									
						F									
						T									
						E									
						C									
						F									

\# - Panel Number
S - Substrate
CS - Carbon Steel
Gal - Galvanized
Cor - Cor Ten
A1 - Aluminum

PC - Preconditioning
Ex - Exposed
U - Unexposed
SP - Surface Preparation
HC - Hand Cleaned
SB - Sandblasted I, II, III
WW - Water Washed

DFT - Total Dry Film Thickness, mils
Rating - 0 (complete failure) to 10 (no failure)
T - Total Panel
E - Edges
C - Cut Damage
F - Flat Surfaces
*Test Discontinued

TABLE II

Field Panel Test
Corpus Christi - 2 years Exposure

Exposed - Handcleaned, Carbon Steel, Total D.F.T. 5-6 mils

Systems	Rating	Areas of Failures
1. 67-739 Dulux® M.P. 25-055 Dulux® M.P.P. 1 Coat	5.8	Flat surfaces - blistered
2. 67-746 Dulux® M.P. 25-055 Dulux® M.P.P. 1 Coat	3.3	Edges - Flat surfaces
3. 825-8031 Corlar® Epoxy Primer 25-055 Dulux® M.P.P. 1 Coat	3.9	General - all areas
4. 347 -937 Ganicin® OZ 25-055 Dulux® M.P.P. 1 Coat	4.6	General - all areas
5. A05 Primer - Du Pont 25-055 Dulux® M.P.P. 1 Coat	3.[illegible]	General - all areas
*6. 67-746 Dulux® M.P. 25-055 Dulux® M.P.P. 1 Coat	4.6	Edges - flat surfaces
*7. 825-8031 Corlar® Epoxy Primer 25-055 Dulux® M.P.P. 1 Coat	4.4	General - all areas

* Water washed after handcleaning, prior to painting

TABLE III

Field Panel Test
Corpus Christi - 2 Years Exposure

Unexposed, Handcleaned, Carbon Steel, Total D.F.T. 5-6 mils

Systems	Rating	Areas of Failure
1. 67-746 Dulux® M.P. 25-055 Dulux® M.P.P. 1 Coat	6.6	Edges and cuts
2. 373-851 Rust Resistant Primer 25-055 Dulux® M.P.P. 1 Coat	5.6	Edges and cuts
3. 825-8031 Corlar® Epoxy Primer 25-055 Dulux®M.P.P. 1 Coat	6.9	Edges and cuts
4. 825-8031 Corlar® Epoxy Primer 823-8021 Corlar® Epoxy Enamel 1 Coat	6.4	Edges and cuts
5. 5465 VQ Penetrant 825-8031 Corlar® Epoxy Primer 823-8021 Corlar® Epoxy Enamel 1 Coat	5.6	Edges and cuts

TABLE IV

Field Panel Test
Corpus Christi - 2 Years Exposure

Unexposed - Class II Blast cleaned, Carbon Steel

Systems	Ratings	Areas of Failure	Total D.F.T.,mils
1. CarboZinc 11 Imron® - 326 Line 1 Coat	8.7	General - all areas	5-6
2. CarboZinc FD Imron® - 326 Line 1 Coat	7.3	Edges	5-6
3. 347-931 Ganicin® IOZ Imron® - 326 Line 1 Coat	8.0	Edges	4-5
4. 347-937 Ganicin® OZ Imron® - 326 Line 1 Coat	5.4	Edges and cuts	5-6
5. Dimetcote® EZ Imron® - 326 Line 1 Coat	6.2	Edges	3-4
6. 347-931 Ganicin® IOZ Imlar® - 802-401 1 Coat	9.8	None	6-7
7. 347-931 Ganicin IOZ Prufcoat H.S. Vinyl 1 Coat	9.8	None	10-11
8. 347-931 Ganicin IOZ 823-8021 Corlar® Enamel 1 Coat	9.3	Edges	6

TABLE V

Field Panel Test
Corpus Christi - 2 Years Exposure

Unexposed - Class I-Blast Cleaned, Carbon Steel - Surface Profile Study

Systems	Profile, Mils	Rating	Areas of Failure	Total D.F.T., Mils
1. 347-931 Ganicin® IOZ 1 Coat	.9	9.1	Edges	2-3
2. 347-931 Ganicin® IOZ 1 Coat	1.5	8.7	Edges	2-3
3. 347-931 Ganicin® IOZ 1 Coat	3	8.7	Edges	3-3.5

TABLE VI

Field Panel Test
Corpus Christi - 1 Year Exposure

Unexposed - Class II-Blast Cleaned, Carbon Steel, Total D.F.T., 7-8 Mils

Systems	Rating	Areas of Failure
1. 347-937 Ganicin® OZ Imron® H.B. 369 Line 1 Coat	9.2	Cuts
2. A05 Primer Du Pont Imron® H.B. 369 Line 1 Coat	5.5	Cuts
3. 825-8031 Corlar® Epoxy Primer Imron® H.B. 369 Line 1 Coat	8.6	Cuts
4. 347-931 Ganicin IOZ Imron® H.B. 369 Line 1 Coat	9.2	Cuts

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TABLE VII

Field Panel Test
Corpus Christi - 1 Year Exposure

Unexposed Carbon Steel - Topcoated - Imron® 326 Line 2 Coats - Total,D.F.T. 5-7 Mils

System	Surface Preparation	Rating	Areas of Failure
1. 825-8031 Corlar® Epoxy Primer	+ SB-I-24 hrs	6.3	Cuts
2. 347-931 Ganicin® IOZ	" "	9.6	None
3. 373-851 Rust Resistant Primer	" "	8.9	None
4. 825-8031 Corlar® Epoxy Primer	* HPWA-24 hrs	6.8	Cuts
5. 347-931 Ganicin® IOZ	" "	9.4	Cuts
6. 373-851 Rust Resistant Primer	" "	8.8	Cuts
7. 825-8031 Corlar® Epoxy Primer	** HPWAI-24 hrs	7.8	Cuts
8. 347-931 Ganicin® IOZ	" "	9.7	None
9. 373-851 Rust Resistant Primer	" "	7.5	None

* HPWA-24 hrs - High Pressure Water + Abrasive - 24 hrs before priming

** HPWAI-24 hrs - High Pressure Water + Abrasive and Inhibitor - 24 hrs before priming

\+ Sandblasted Class I - 24 hrs before painting.

TABLE VIII

Field Panel Test
East Chicago - 1 Year Exposure

Exposed - Hand Cleaned Carbon Steel

Systems	Rating	Areas of Failure
1. 67-739 Dulux® M.P. 25-055 Dulux® M.P.P. 2 Coats	7.3	Cuts
2. 67-746 Dulux® M.P. 25-055 Dulux® M.P.P. 2 Coats	8.4	Cuts
3. 373-851 Rust Resistant Primer 25-055 Dulux® M.P.P. 2 Coats	7.6	Cuts
4. 5465 VQ Penetrant 825-8031 Corlar® Epoxy Primer 823-8021 Corlar® Enamel 2 Coats	5.7	Cuts
5. 825-8031 Corlar® Epoxy Primer 823-8021 Corlar® Epoxy Enamel 2 Coats	5.8	Edges and cuts
6. 373-851 Rust Resistant Primer 67-813 Dulux® M.P. Imron® - 326 Line	6.3	Cuts and flat surfaces

TABLE IX

Field Panel Test
East Chicago - 1 Year Exposure

Unexposed - Class II Blast Cleaned Carbon Steel

System	Rating	Areas of Failure
1. 347-931 Ganicin® IOZ 823-5080 Corlar® H.B. Imron® 326 Line	9.7	None
2. 347-931 Ganicin® IOZ Imron® H.B. - 369 Line 1 Coat	8.8	Edges
3. 825-8031 Corlar® Epoxy Primer Imron® H.B. 369 Line 1 Coat	6.6	Edges and cuts
4. 347-931 Ganicin® IOZ 802-401 Imlar® Vinyl 2 Coats	9.7	None
5. 825-8031 Corlar®Epoxy Primer 802-401 Imlar® Vinyl 2 Coats	9.4	Cuts

NEW DEVELOPMENTS IN DU PONT MAINTENANCE FINISHES

E. J. Zinser

Bob McCormick acquainted you with the results of some ESD field panel tests. I am glad to see that our systems fared so well. I'm sure you are also pleased because these are the very systems which are protecting your plants.

Before I get into the technical part of my talk, I would like to review briefly, for those of you who may be new to this meeting, who Du Pont Maintenance Finishes is and what we do. Du Pont Maintenance Finishes is a business within the Finishes Division of the Fabrics & Finishes Department. We develop, test, supply, and service high-performance, high-value-in use coatings designed to protect plant investment from the ravages of its environment.

You can obtain our coatings in one of two ways. First, after consulting the appropriate Engineering Standard, you can buy them and supply and supervise your own labor to apply them to your plant. Secondly, you can contract with our Maintenance Painting Service to survey your plant and supply labor, materials, and supervision for the paint job. Len Sherman, Marketing Manager of our Maintenance Painting Service, will tell you more about "MPS", as we call it.

Now that you know who we are and what we do, let me tell you where we operate. We have divided the country basically into a West and East marketing zone. Each zone has two regional marketing offices. Your orders are received and processed in these zone offices and material is shipped to you from warehouses in our distribution network or from our manufacturing plants. If you do not know the name of the Du Pont representative who calls on your plant or have not seen him lately, please see me after this meeting and I will make sure that contact is established.

Today I would like to review five topics: Starblast®, Arctic Ganicin®/Imron®, Environmental Colors, Product Ordering Simplification, and Flintflex Fusion Bonded Pipe Coatings.

Starblast®

Starblast® is a premium loose abrasive derived from a blend of coarse and fine staurolite sands mined from Du Pont's Starke, Florida, mineral deposit. It is a naturally occurring mineral and is primarily composed of aluminum and iron oxides. It also contains a maximum of 5% free silica. To our knowledge, no one

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but Du Pont mines and markets this novel abrasive. Starblast® is especially valuable in removing mill scale and light rust from metal and also for cleaning dirt and stains from masonry surfaces. It has a high cutting rate when used in these applications and can significantly reduce your surface preparation costs.

Starblast® is a low dusting abrasive -- it does not break down readily -- and is especially valuable for use in close or confined areas. Consider using Starblast® the next time you plan to blast a tank interior. Utility companies choose Starblast® for use in areas where electric motors could sustain severe dust damage if sand or Black Beauty were used. Because Starblast® does not readily break down, you may reuse it if you are equipped to recycle abrasive. This further reduces your actual abrasive cost.

Starblast® will work in all air blast equipment designed for loose abrasives. However, application-wise, you will find that a much leaner air/abrasive mixture is used than with conventional abrasives. In fact, you will be amazed at how little Starblast® is used in the air/abrasive stream. Starblast® is available in 100-pound bags or bulk and can be readily loaded into the blasting equipment you have now.

Recently we made a move which dramatically shows the potential benefits available to a user of Starblast®. I would like to show that movie to you now ("Du Pont Starblast® Story").

I think you will agree with me that the two most outstanding attributes of Starblast® which we saw in the film were its high production rate and its low dusting. Could you use an abrasive that will remove mill scale and light rust three times faster than sand? I should point out that this factor of three for Starblast®, over sand, is reduced when Starblast® is used to remove paint. In this case, Starblast®, on a per-pound basis, is still more effective than sand but, because of its higher cost, the advantage diminishes. Some people mix Starblast® and sand together to remove paint and find that it is far superior to sand by itself on a cost and performance basis.

You can best determine if Starblast® can help you by running a trial at your site. This way you can compare Starblast® in your equipment, on your site, side by side with your current abrasive. Joe Mulvey, our distribution manager for Starblast®, will be glad to arrange a trial of Starblast® at your site.

<u>Arctic Ganicin®/Imron®</u>

As you are well aware, the petroleum industry is currently engaged in a multi-billion-dollar construction campaign to obtain and move oil from the north slope of Alaska to the terminal at Valdez in southern Alaska. Steel well structures, pipelines, pumping stations, and storage tanks will, of course, require protection

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from the hostile Arctic environment. Ideal protection will be rendered by a coating system with the potential of 15 to 20 years' durability; resistant to mild, salty air; resistant to the abrasion of snow and ice driven by high winds; and resistant to thermal shock as low as -60°F. Such a coating system will also have to be capable of application at temperatures in the vicinity of 25°F and preferably as low as 0°F. If the Alaska construction industry could paint at temperatures as low as 0°F, the short painting season would be extended by almost three additional months. If you think that application costs are high at your plant site, compare your figures with those being sustained by the Alyeska Pipeline. It costs them $250 per day to keep a painter in the field. The painting costs we pay are small in comparison.

Realizing that this high value-in-use market was in need of new technology, Du Pont Maintenance Finishes undertook a research program designed to provide a durable primer and topcoat system which could be applied in the rigorous Alaskan climate. After reviewing the coating properties required for Alaska, we decided that a two-coat system comprised of Ganicin® Inorganic Zinc and High-Build Imron® Polyurethane Enamel would be best suited for the Arctic environment. We therefore directed the efforts of our research team toward redevelopment of these products so they could be applied under the cold, dry Arctic conditions. After months of testing in low-temperature facilities at our Marshall Laboratory and at Louviers, our Arctic quality coatings were ready for field trials. Last November, Roy Allen and several members of the Maintenance Finishes technical team traveled to Anchorage, Alaska. There, at the Union Oil Terminal on Cook Inlet, a 30-foot-high petroleum stroage tank was finished with our Arctic Ganicin® and High-Build Imron® coatings. We recorded that test for you on movie film, and I would like to show it to you now ("The Arctic Imron® Story").

I think you will agree with me that that was a dramatic and severe test to subject a coating to. And, I am sure you are asking yourselves, "What does that mean to me since I don't have to paint in Alaska?" A good question! Reese DeWitt from Chambers Works knows the answer. Earlier this year, Reese cooperated with us when we field tested Arctic Ganicin® at Chambers Works. I understand it performed to all of Reese's expectations and gave him the capability to blast and prime with inorganic zinc all year round in this northeastern environment. I strongly suggest that those of you who work in plants which get a severe winter consider expanding your painting horizons to include Arctic Ganicin®.

Our new Ganicin® also offers advantages to those of you who are fortunate enough to live and work in a temperate southern climate. More and more plants are setting up what they call a "paint yard" where pipe and structural steel is blasted, primed, and topcoated prior to installation. If you use our

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new Ganicin® as a shop primer, you can move and handle the steel 30 minutes after application. Shouldn't you consider using this Ganicin® in your painting operations? We plan to commercialize our new Ganicin® this summer -- our Arctic Imron® will follow.

I have been using the term High-Build Imron®, and it dawns on me that some of you, although I hope not many, may not be familiar with this product. In 1969 Du Pont revolutionized the maintenance finishes industry by introducing its Imron® polyurethane enamel. Imron® enamel gave the user exceptional gloss and appearance retention, unusual thoughness and physical durability, excellent resistance to chemical attack, and fast drying and recoat times. It was generally used in chemical plants as the topcoat of a three-coat system comprised of Ganicin® inorganic zinc, High-Build Corlar® Epoxy Enamel, and an Imron® topcoat. A dry film thickness of 1.5 to 2.0 mils could easily be obtained in one pass. In 1973 Du Pont again revolutionized maintenance finishes by introducing High-Build Imron® Polyurethane. High Build Imron® possessed not nly all the properties of the earlier Imron®, but it could be applied at 6 to 7 mils dry film thickness in one cross coat. High-Build Imron® is used over Ganincin® Inorganic Zinc to provide a two-coat system which is extremely durable, chemically resistant, economical as well because of reduced labor costs.

Environmental Colors

Earlier in this presentation, I discussed our geographical organization. This structure resulted from a reorganization of the Maintenance Finishes Group in the early 1970's. At that point, Jack Graham, our National Manager, was charged with organizing a viable, contributing, profitable maintenance finishes business. One of the many problems Jack faced was related to the product line. At that time the Maintenance Finishes product line consisted of over 1,600 miscellaneous products and colors. As such, it was totally unmanageable because more often than not the wrong items were usually the ones that were in stock. Thus, one of the questions we asked ourselves was, "What colors must we keep?" To answer this, we carefully scrutinized the complete product line. We had some very attractive items. The overall shape was good, but not all of the items really belonged together.

After much deliberation, we decided to take an approach which today is well known throughout the industry as the "Du Pont Environmental Color System". Think for a minute of the colors you see about you every day in nature -- the soft blues of the sky, streams, sea -- the warm yellow tones of dry brush, stone, and sand beaches -- the clean greens of the forest. These are the major colors of our natural environment. Contrast these with the colors of our man-made environments -- the strong, bright yellows and greens; the strident high visibility reds and oranges; and the sparkling metallics. When you use man-made colors to paint a structure, be it a chemical plant or a house, you make it stand out from its natural background.

Think for a moment of a quiet, green forest bordering a sparkling lake. Now, put two structures on adjacent lots. On one, put an A-frame cottage painted with several different, brightly colored, high-gloss enamels. On the other, put a one-story cottage and finish it with field stone and weathered cedar. The first structure, while in shape is in unity with the setting, still stands out because of the choice of colors. The other, with natural or environmental colors, blends well with its natural surroundings. It goes without saying that the visual pollution that has afflicted us need not always exist. True, our structures and facilities must be built somewhere; but when they are, they should be designed to harmonize rather than clash with their terrain.

Color is a subtle and powerful tool in "naturalizing" our factories, plants, and buildings. Color, when used properly, can minimize visual pollution inherent in many of our industrial structures. Color transforms eyesores into pleasing views, improves community relations, and makes our workplaces attractive to behold.

The various colors in the Du Pont Environmental Color System were selected for two reasons:

- To enable industry to use those colors which will bring about the greatest harmony between man-made structures and the environment in which they exist.

- To enable you to select the best color combination for your part of the country.

We have divided the United States into nine areas. Each area tends to have its own particular combination of topography and climate and should have its own color scheme. The Environmental Color System brochure contains a map which has been reproduced with a color key -- keying the Du Pont Environmental Colors to the nine geographical areas. Now, if you feel that your particular needs call for colors other than those specified in your geographical area, you can rest assured that any other color that you might pick from the Du Pont Environmental Color System will coordinate well with the ones that are specifically designed for that area.

This brings me to the subtopic of old, special, or discontinued colors. Some of the colors which you have used in the past are no longer readily available. For touch-up you can obtain, through our Custom Color System, at a slight cost penalty, sufficient paint to enable minor touch-up. However, when it comes to painting new structures, it is in your best interest to choose colors from our Environmental Color System. Virtually all of these colors are stock items and are readily available. You can have them in the quantity you need when you need them. Special colors, however, cost more; filling orders takes a little longer and will not measurably contribute to most color schemes. A

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major exception to this statement is interior paint. Now, you may broaden your palette by moving away from the Environmental Color System to colors available from our Color Planner. While the latter are mixing machine formulas, the components are readily available and the cost and delivery times are attractive. Also, bear in mind, we offer a Color Advisory Service and would be pleased to help you select colors to enhance and unify your workplace environment. I know that some of you in this room have already taken advantage of this service.

Product Ordering Simplification

As I indicated earlier, our business was reorganized in the early 1970's, and many products were brought together into one business. One of the areas identified as needing improvement was distribution. We do recognize that in the past it has been difficult to get timely delivery of our products. Last year, our new Houston Maintenance Finishes warehouse went into operation. This warehouse is the prototype for our new distribution network. Orders for stock items received in Houston before 2:00 p.m. are shipped the same day. I believe that those of you in areas serviced by our Houston warehouse can testify to the improvement in service. Within the next quarter, our West Chester, Pennsylvania, warehouse will be able to provide you with this same type of service. We are committed to providing on-time delivery of our products to you -- our customers.

We believe we have retained in our product line a high-powered stable of functional products. However, as you well know, the coding system for these products is replete with numbers and there is little systemization within it to allow the potential user to easily commit numbers to memory. Let me illustrate this by showing you our current Line Quality Index (Figure 1). See, for example, the Environmental Color Number 104, Cirrus Gray, which is available in six different qualities; it is also available under six different codes, only two of which show any any numbering similarity which might lead you to believe that they were the same color in different qualities. Here I am referring specifically to the Imron® 326 and 369 lines. Note that the first three digits, 326 and 369, refer to the quality or line number while the last five digits, 67637, refer to the color number. We are currently considering revision of our Line Quality Index and numbering system to resemble that shown in Figure 2. Let's look again at Cirrus Gray. Note now that in all cases but Lucite® House Paint, the number 67637 clearly tells you the color is Cirrus Gray while the preceding two or three digits indicate the quality or, to use a non-F&F term, the type of finish. Note that the Lucite® numbering system has not changed. Lucite® uses a different kind ofnnumbering system because it is a consumer product and we do not propose to change this numbering system. Don't let the KT's or XYZ's disturb you. Since this is currently a proposal, we have not assigned numbers in order to avoid confusion if this chart should inadvertently be given to a customer.

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FIGURE 1

DU PONT MAINTENANCE FINISHES LINE QUALITY INDEX

EC Number	Name	DULUX® 25-Line Metal Protective Tanks & Structure	DULUX® 81-Line Machinery — Enamel Equipment — Trim	IMRON® 326-Line** Enamel High Performance Coating Chemical Rel. — Color & Gloss Ret. Equip., Tanks, Structure, Etc.	IMRON® 369-Line** High Build Version of 326-Line Tanks & Structure	CORLAR® 823-Line Chemical Resistant Finish Tanks, Structures & Equipment	LUCITE® House Paint — Wood, Masonry & Insulated Surface
101	Storm Blue	C-587*	81-Y-5401	326-Y-67999	—	823 Y 5132	C-587*
102	Falls Blue	25-Y-5134	C-602*	326-Y-67638	369 Y 67638	823-Y 5134	C-602*
103	Shale Gray	25-Y-5142	81-Y-24919	326-Y-67633	—	823 Y 8021	1310C
104	Cirrus Gray	25-Y-5143	C 654*	326-Y 67637	369-Y 67637	823 Y 8234	231C*
105	Meadow Green	25-Y-5026	81-Y-23309	326 Y 67642	369 Y 67642	823 Y 8010	C 546*
106	Briney Green	C-560*	C 560*	326-Y 67646	—	823 Y 5136	C 560*
107	Terra Green	25-Y-5133	81-Y-5402	326-Y 67639	—	823 Y 5133	C 594*
108	Ice Blue	C-577*	C 577*	326 Y 68000	—	C 577*	C 577*
109	Big Sky Blue	W 677*	W-677*	326-Y-68001	—	W-677*	W-677*
110	Glade Green	25-Y 5139	81 Y 5408	326-Y 67846	369 Y 67846	W 667*	1301C
111	Canyon Sand	W 623*	81 Y 35472	326-Y 67636	—	823 Y 8019	1321C
112	Mesa Gold	W-626*	W 626*	326-Y-68002	—	W 626*	W-626*
113	Clay Tan	25-Y-5138	W-549*	326 Y 67635	369 Y 67635	W-549*	W 549*
114	Earth Red	W 538*	W 358*	326-Y-68003	—	823-Y 5148	1307C
115	Coastal Beige	W 564*	81-Y-5409	326-Y-67641	369-Y-67641	823-Y-5139	1302C
116	Bark Brown	25-Y-5144	W 608*	326-Y-68004	—	823-Y-5144	1311C
117	Loam Brown	W-614*	81-Y-5417	326 Y-67645	—	W-614*	W 614*

O.S.H.A. SAFETY COLOR CODES

	High Visibility Yellow	—	81-23663	326 Y 67673	—	—	—
	Fire Protection Red	—	81 23664	326 Y 67706	—	—	—
	Precaution Blue	—	81 23665	326 Y 67755	—	—	—
	Alert Orange	—	81 23662	326 Y 67674	—	—	—
	Safety Green	—	81 23666	326 Y 67752	—	—	—

**IMRON® available in factory package only

*Not available in factory package may be tinted as follows. 25 Line or 81 Line — Tint in 88 Line DULUX® Base 823 Line CORLAR® — Tint in 823 Line CORLAR® Base
LUCITE® House Paint — Tint in LUCITE® Base

FIGURE 2

DU PONT MAINTENANCE FINISHES LINE QUALITY INDEX

EC Number	Name	DULUX® 96-Line Metal Protective and Machinery Enamel	IMRON® 326-Line**† Enamel High Performance Coating Chemical Res.—Color & Gloss Ret. Equip., Tanks, Structure, Etc.	IMRON® 369-Line**† High Build Version of 326-Line Tanks & Structure	CORLAR® 823 Line† Chemical Resistant Finish Tanks, Structures & Equipment	CORLAR® 887 Line† High Build Chemical Resistant Finish	LUCITE® House Paint—Wood, Masonry & Insulated Surface
101	Storm Blue	96-Y-67999	326-Y-67999	—	823-Y-67999	—	C-587*
102	Falls Blue	96-Y-67638	326-Y-67638	369-Y-67638	823-Y-67638	—	C-602*
103	Shale Gray	96-Y-67633	326-Y-67633	—	823-Y-67633	887-67633	1310C
104	Cirrus Gray	96-Y-67637	326-Y-67637	369-Y-67637	823-Y-67637	887-67637	231C*
105	Meadow Green	96-Y-67642	326-Y-67642	369-Y-67642	823-Y-67642	—	C-546*
106	Briney Green	IM-67646*	326-Y-67646	—	823-Y-67646	887-67646	C-560*
107	Terra Green	96-Y-67639	326-Y-67639	—	823-Y-67639	—	C-594*
108	Ice Blue	IM-68000*	326-Y-68000	—	IM-68000*	—	C-577*
109	Big Sky Blue	IM-68001*	326-Y-68001	—	IM-68001*	—	W-677*
110	Glade Green	96-Y-67846	326-Y-67846	369-Y-67846	IM-67846*	—	1301C
111	Canyon Sand	96-Y-67636	326-Y-67636	—	823-Y-67636	—	1321C
112	Mesa Gold	IM-68002*	326-Y-68002	—	IM-68002*	—	W-626*
113	Clay Tan	96-Y-67635	326-Y-67635	369-Y-67635	823-Y-67635	—	W-549*
114	Earth Red	IM-68003*	326-Y-68003	—	823-Y-68003	—	1307C
115	Coastal Beige	96-Y-67641	326-Y-67641	369-Y-67641	823-Y-67641	—	1302C
116	Bark Brown	96-Y-68004	326-Y-68004	—	823-Y-68004	—	1311C
117	Loam Brown	96-Y-67645	326-Y-67645	—	IM-67645*	—	W-614*
—	Black	96-Y-67640	326-Y-67640	—	823-Y-67640	887-67640	1305C
—	White	96-Y-67632	326-Y-67632	369-Y-67632	823-Y-67632	887-67632	50C

O.S.H.A. SAFETY COLOR CODES

	High Visibility Yellow	96-Y-23663	326-Y-23663	—	—	—	—
	Fire Protection Red	96-Y-23664	326-Y-23664	—	—	—	—
	Precaution Blue	96-Y-23665	326-Y-23665	—	—	—	—
	Alert Orange	96-Y-23662	326-Y-23662	—	—	—	—
	Safety Green	96-Y-23666	326-Y-23666	—	—	—	—

*Not available in factory package may be tinted as follows 96-Line—Tint in 96-Line DULUX® Base 823-Line CORLAR®—Tint in 823-Line CORLAR® Base LUCITE® House Paint - Tint in LUCITE® Base

**IMRON® available in factory package only

†This two package product must be mixed with correct activator prior to use. Consult appropriate technical brochure for details

DULUX® alkyd enamel, IMRON® polyurethane enamel, CORLAR® epoxy enamel and LUCITE® house paint are registered trademarks of the Du Pont Company.

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You will also note one additional simplification and change. Over the years you have stocked and used Dulux® 25-Line metal protective finish for tanks and structures and also Dulux® 81-Line machinery enamel. We propose to sell one product, Dulux® Metal Protective and Machinery Enamel, which will perform as well in either end use as 25 and 81 Lines do for you now. We believe this new simplified order numbering system and uni-quality Dulux® line will simplify ordering and inventorying of our finishes for you the customer. I should emphasize that these are proposed changes; their implementation has not yet been approved; and I ask you not to discuss them outside this room. In the event that these changes are instituted, you will be given ample notice and all line indexes and descriptive literature will be revised to show the new numbering system. We will also prepare an equivalence chart to facilitate a smooth transition.

Flintflex® Fusion-Bonded Pipe Coating

Flintflex® fusion-bonded pipe coating was developed in the early 1970's after a thorough market analysis of the underground pipe industry. It is derived from a thermosetting epoxy resin and formulated for electrostatic application to properly cleaned, preheated pipe at a nominal 12-mil thickness. It has been formulated to provide excellent pipe coating performance when applied directly to metal.

Buried Pipe Systems

Flintflex® coated pipe is used primarily in buried pipelines. In this use the fusion-bonded coating offers many benefits:

- Mill Coated -- This provides uniform thickness of the protective coating and thorough inspection in the coating facility.

- It has proven disbondment characteristics that are minimal in conjunction with cathodic protection systems.

- Flintflex® resists moisture penetration because the fusion-bonded coating process assures maximum adhesion.

- Operating temperature parameters vary from far below 0°F to 250°F without loss of physical properties.

- Soil stress resistance, chemical resistance, and performance in brine solutions have been proven in service.

- Recent research demonstrates that Flintflex® is an excellent candidate as a base coating for concrete weight coatings to be used off-shore.

- Flintflex® also has demonstrated the ability to maintain its flexibility for field bending at -50°F.

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- It has proven impact and abrasion resistance. Pipe, therefore, sustains little in-transit damage.

- Flame tests show that Flintflex® pipe coating performs extremely well under the intense heat of the welder's torch. Only a minimum of coating will burn away without blistering or peeling in pipe areas adjacent to the weld.

Above-Ground Systems

Flintflex® is starting to be used for above-ground systems with a top coat of Imron® for extra chemical and ultraviolet resistance. We are currently developing another system for above-ground pipe and structural steel. This system would consist of Ganicin® Inorganic Zinc as a base coat (to provide cathodic protection or underfilm corrosion resistance especially in areas where the top coat may be damaged), Flintflex® electrostatically applied as an intermediate coat, and finally an Imron® top coat. The Ganicin® in this system would give corrosion protection analogous to that provided by an induced electrical current on a buried pipeline.

As you well know, construction costs have risen sharply in the past few years. Pipe racks are one of the most costly and difficult parts of a plant to paint. The resultant paint job is usually far from perfect. Think for a moment what it would be like to construct a pipe rack from pipe which has already been shop coated with a high performance coating system. You need only blast and repaint weld and damage areas. This is where we feel the Gaincin®/Flintflex®/Imron® system we are experimenting with will find utility and save you money.

Coated Reinforcing Steel (Rebars)

Over 29 million feet of reinforcing steel in bridge decks was coated with epoxy powder in 1975. Du Pont's Flintflex® enjoyed about 75% market penetration. The deterioration of concrete bridge decks only five to ten years old has become a major problem during the past decade. An estimated $200 million a year is spent on bridge deck repairs.

The principal cause of this premature deterioration is the effect of corrosion on the reinforcing steel. This corrosion process is hastened by the penetration of deicing materials through the concrete and their coming in contact with the steel; in particular, sodium and clacium chlorides when entering into solution with moisture form an electrolyte, a fundamental component of the corrosion process.

As a result, in areas where the use of deicing compounds is necessary, bridge deck structures which would otherwise have a projected useful life of up to 30 years are showing extensive deterioration after as few as five years.

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The corrosive process expands the volume of the reinforcing steel. This expansion creates pressure on the concrete and ultimately results in cracking and spalling. In a relatively short time, the surface damage may be sufficiently severe as to require costly repairs or full-scale bridge deck replacement.

Application of Flintflex® Fusion-Bonded Coatings

Let us now examine how Flintflex® fusion-bonded pipe coatings are applied. Experience has shown that proper application techniques must be utilized to obtain the desired results since the application process assures coating integrity.

The first step in the coating process is a thorough shot-blast cleaning of the steel to remove mill scale and other extraneous surface contaminants; i.e., the surface has to be prepared properly to receive the epoxy powder coating. After cleaning, the steel moves to a high-temperature oven where the precoating application temperature is reached.

When the proper temperature is achieved, the steel passes through an application zone where electrostatic spray guns apply the charged epoxy powder. The coating material melts, flows, gels, and cures on the steel to a desirable coating thickness. After curing, the steel passes through a water-quenching operation to facilitate handling.

Each piece of steel is subjected to electronic inspection for coating imperfections. If a surface defect is found, the point is marked and repairs are made before the steel leaves the coating area.

Through the use of this highly automated coating process, proper application can be accomplished simultaneously with optimum quality at a reasonable cost.

Du Pont Flintflex® applicators are conveniently located near the major pipe and rebar consumption areas.

Chuck Cooke, Senior Sales Representative for our Flintflex® powder coatings would be happy to discuss your potential application for Flintflex® and answer any questions you may have.

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UPDATE ON F&F DEPARTMENT'S MAINTENANCE PAINTING SERVICE

L. M. Sherman

As we enter the fifth season for Du Pont's Maintenance Painting Service, it seems appropriate to review how the business has been developing. In physical terms, the growth has been gratifying indeed: In 1972 MPS was active at two plant sites; By 1975 this had increased to 17; and the forecast for 1976 is 29. Last year six of the 17 sites were Du Pont plants.

In terms of market concentration, the chemical industry has been and continues to be our major customer. The petroleum industry is a poor second. We have had only one pulp and paper mill.

We continue to follow pretty much the original marketing plan with respect to geographical concentration. The Gulf Coast is our major market, with six sites in Texas and three in Louisiana in 1975. The Delaware Valley has the second largest concentration.

The size of the MPS projects, in terms of their annual budgets, range from $50M to over $1MM. However, the average size in 1975 was $340M, and most of the projects fall in the range of $100M to $750M. The growth for 1976 appears to be mostly in this range also.

In 1976 we expect to be active at 12 Du Pont sites; seven are already active or are carryover programs from 1975; the other five are in various stages of development. We will also be active on at least 17 sites, representing 11 other companies; there are nine additional projects under development for these and other companies.

Of course, numerical data fall far short of fully describing any program. Perhaps more important, particularly in the case of a service program, is the manpower. Just by way of explanation, here is a brief description of how we operate:

The Zone Managers who have responsibility for paint sales also have primary responsibility for initiating and supervising original contacts with MPS prospects. Prospects are chosen on the basis of criteria established by MPS (with respect to size, location, type of plant, etc.) or by broader sales considerations identified by our National Manager. The Zone Manager has as resources for the initial call and followup not only his own sales organization but also various members of the MPS organization as needed.

Once the prospect has accepted the concept and authorized a survey, responsibility falls to the project engineer to whom the site is assigned to develop the program and achieve its adoption. During the first phase, the survey, he may be assisted by a Field Engineer; during the final phase, presentation and selling of the completed program, he is supported by the sales organization. Throughout all phases, he works under the direction and supervision of his Project Manager.

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Contract administration is the primary responsibility of the Project Manager. At least two contracts are required for every job: one with the customer and one with the labor subcontractor. Sometimes the job is divided among more than one subcontractor. The Project Manager is assisted in some phases of his work, particularly the preparation of accomplishment reports, compensation of contractors, and billings to customers, by the Field Engineer.

Control over the execution of the project is the primary responsibility of the Field Engineer. He is Du Pont's continual representative on the job and provides the interface among the customer, contractor, and Du Pont. Scheduling, adherence to specifications, and coordination are his major concerns. Recent experience has shown us that this job can be rather demanding in terms of diplomacy and labor relations skills, as well as painting technology. He is supported by the Project Manager and the Project Engineer, depending upon the nature of the current problem.

The organization chart portrays the current situation. It shows 14 Field Engineers, three Project Engineers, and one Account Manager doubling as a Project Engineer, two Project Managers, and one Marketing Manager doubling as a Project Manager, and one Marketing Assistant. (The Marketing Manager's job, briefly stated, is to provide program direction and act as the program's interface with staff functions such as Advertising, Legal, Purchasing, and Accounting.)

Clearly, the rate and direction of growth for a program like this is heavily influenced by the availability of personnel and our capacity to train them. Fortunately, during the recent period of limited manpower availability, we have been able to benefit from our policy of concentration by area, as well as by industry. As more sites become active in any one area, our manpower utilization becomes more efficient. In January of this year we began a series of formal training sessions, with the important assistance of Roy Allen and others in the Engineering Department.

In a program growing as rapidly as MPS, it is difficult to find as much time to devote to program development as we would like; but we have been making progress in some areas, nevertheless. There are three areas of development that I think deserve mention here. The first is labor estimating. Our initial method has been based almost solely on man-hour estimates for every structure; we are increasingly using estimates based on area measurements, or a combination of these methods. This, together with planned further refinements in the computer program into which these data are fed, is expected to improve the precision of our project engineering and the speed and efficiency with which we develop our proposals.

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Contract management is another area in which we are developing further expertise, with the help of our advisors in the Energy & Materials Department and the Legal Department. We are constantly trying to achieve fairness to the subcontractor, performance for the customer, and profitability for Du Pont. This isn't always an easy task, and new situations are always arising. We are continually looking for better ways to buy labor and provide it with clear and complete specifications.

The third area of constant development is site management, the primary responsibility of our Field Engineers. The constant surveillance over the quality of work, the frequent need for scheduling changes, the concern for proper and safe working practices put heavy burdens on these men. Procedures have been developed to make as much of this work as standard and routine as possible without any sacrifice in performance, leaving more time for the Field Engineer to work on the special problems that arise on his site.

It's been a pleasure to bring you up to date on Du Pont's Maintenance Painting Service.

ORGANIZATION
MAINTENANCE PAINTING SERVICE

National Manager - Maintenance Finishes	Graham
Marketing Manager - M.P.S.	Sherman
Marketing Assistant - Wilmington	Carson
Field Engineer - Chicago	Huffman
Project Engineer - Wilmington	Shellem
Field Engineer - Philadelphia	Mc Fassel
Field Engineer - Wilmington	Schmidt
Project Engineer - Charleston, W. Va.	Fliegner
Field Engineer - Belle, W. Va.	Taggart
Zone II Marketing Manager - Houston	Shipp
Account Manager - Los Angeles	Leeder
Field Engineer - Los Angeles	Ferguson
Project Manager - Houston	Donaldson
Project Engineer - Houston	Smith
Field Engineer - Houston	Kruk
Field Engineer - Houston	Rounsavall
Field Engineer - Houston	Vernier
Field Engineer - Beaumont	Davis
Field Engineer - Orange	Emmons
Project Manager - New Orleans	Shay
Field Engineer - New Orleans	Dubuc
Field Engineer - Lake Charles	Royal
Field Engineer - Naheola	Turner
Field Engineer - Memphis	Mc Carty

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PAINTING GALVANIZED STEEL - COST AND COMPARISON

M. B. Harkins

When exposed to moist air, ferrous metals (those containing iron and steel) will rust. Immersed in water, buried in the ground or exposed to the air we breathe, moisture is present and attack is certain, unless special precautions are taken to prevent rust and corrosion.

It is estimated corrosion in the United States costs industry $12 to $15 billion or more yearly. Some managers consider this is the business of the maintenance people. Most of them feel they have more important things to think about than coatings. Many times the decisions for the coating systems are made by those responsible for constructing and not those responsible for the operating or maintenance.

We all know maintenance alone is not the way to fight a $15 billion problem.

You must start to solve the problem when:

- job site practices are developed.
- the new construction specifications are assembled.
- you purchase structural steel.
- you purchase coating to match the facility.
- you make maintenance job assignments.

There are, of course, many other situations. And, the problem should not be left for a few men in the maintenance department after all the above areas have been overlooked.

Today let's continue our discussion on the item of structural steel.

Recent months have been very turbulent as far as prices are concerned. Prices of bare steel, on which protective coatings are applied, have jumped wildly and have broken all past records.

Due to worldwide inflation, labor has become more costly. Regardless of the period, even in unstable times, costs and comparisons have to be made almost daily, but certainly monthly.

This is the reason for the concern of designers, engineers, coatings producers, corrosion engineers, and the owners of the facilities to be protected.

In order to make the correct selection of the proper protective coating to protect this structure, the following factors must be considered:

- initial costs
- coating life
- repainting costs
- repainting cycle
- inflation
- rate of return on assets employed
- etc.

For me to tell you today that we are going to do everything the way we were doing things 18 to 24 months ago would be obsolete. However, for purposes of our discussion, the selection will be made between hot-dip galvanizing and painting.

Once again it's the same old story of apples and oranges. The person who owns an apple orchard will do his best to convince you that apples are better than oranges. The person who owns the orange grove will do his best to convince you oranges are better than apples. The owner of a hot-dip galvanizing plant will do his best to convince you galvanizing is better than painting. The paint manufacturer will do his best to convince you painting is better than galvanizing.

The facts look like this: The present market (April, 1976) indicates that hot-dip galvanizers are very, very competitive with each other. On the other hand, the paint contractors are not. Galvanizing has a definite trend to fluctuate with the economy of the times.

Normally hot-dip galvanizing is priced by weight and painting by surface area. Therefore, the cost must be made to apply to some ratio of weight to surface area. To have the unit cost per ton the same, the paint costs are multiplied by 225 square feet, average square feet per ton of steel.

<u>Table 1</u>

	Cost per Ton	Date
Galvanising	$120	4/15/76
Painting (2-mil DFT Inorganic Zinc)	$ 60-70	4/15/76

Dates represent the time of the quotation for that actual cos figure. These figures are actual cost figures from Owens Ste Company, Columbia, South Carolina.

The painting cost figure includes Wheelabrator cleaning to SSPC SP6. To obtain this, the Wheelabrator speed is set at 5 to 7 feet per minute, run through, stopped, backed up, steel rotated 90 degrees and run through at the same speed.

Estimated cost for cleaning is $25 to $30 per ton. The surface is sprayed immediately with one coat of inorganic zinc at the rate of 2 mils DFT. Cost for inorganic zinc and labor applied is $35 to $40 per ton, making the $60 to $70 per ton cost shown in Table 1. Inorganic zinc coatings contain approximately 0.7 ounce of zinc per square foot or less for a 3-mil DFT.

Hot-dip galvanizing of structural steel shapes, plates, bars, etc., provide for an average of not less than 2.3 ounces of zinc per square foot of surface area with no individual specimen showing less than 2.0 ounces, as covered in ASTM Specification A123-65.

Needless to say, the life expectancy of any coating depends upon process conditions in the areas and the corroding effects of the atmosphere. When done under generally accepted, standard, uniform procedures, and all zinc coatings meet ASTM specifications, hot-dip galvanizing will react the same to varying corrosive conditions. However, due to the various generic types of protective coatings and various methods of application, total dry film thickness, it is impractical to make an exact prediction as to the length of time that protection may be expected.

Back in 1965-1967 we were recommending the purchase of galvanized structural steel versus sandblast cleaning and 2 mils of epoxy primer. Both of these cost figures were $0.35 per square foot for steel purchased in Philadelphia and delibered to Chambers Works. Field painting was required for both systems.

With progress and improvements being made in cleaning techniques in the form of Wheelabrators, inorganic and organic zinc primers, we have advanced to 1976 (no more hot spray). We have seen zinc-rich coatings continue to grow and be used universally as the prime coat for most industrial painted surfaces.

There are still a lot of architectural type primers hanging on in the dry environmental areas. This is due primarily to small fabricators and lack of cleaning facilities. I believe if we advance in the next ten years as we have over the last ten years, 90% of the structural steel will be inorganic steel primed as the standard from fabrication shops. All others will be a special order, and thus an extra cost.

The key is zinc -- whether hot dipped, galvanized, or inorganic zinc primer. Earlier I mentioned that galvanizers were more competitive with the times than paint contractors. In 1972-1973, galvanizing was $0.05 per pound, or $100 per ton. Early in 1974 (within one year) it rose to $0.08 to $0.10 per pound -- $160-$200 per ton. Early in 1975 it hit $0.12 per pound -- $240 per ton. Today (April, 1976) it is back to $0.06 per pound or $120 per ton.

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In this same period of time the paint producers had to raise the price of their zinc coatings from $10 to $12 per gallon to $22 to $25 per gallon. Both prices were influenced by the base cost of zinc.

It is the general consensus that most paint systems in industrial areas will require repair and/or replacement within three to eight years after application.

Let's review the figures shown in Table 2. Special notice should be given to the footnotes on this table.

Table 2

COATING COMPARISON FOR STRUCTURAL STEEL

Case	Coating				DFT (mils)	Attention (yrs)	M&L** Cost/Ton	Engg. Std.
1		Galv.	No Paint	—		15-20	≠$120 $150	SZ9F Para. 5.2
2	II	Inorganic Zinc Primer	High Build Epoxy	Poly-urethane	8.5	8-12	*$207	SZ3D 203
3	II	Epoxy Primer	High Build Epoxy	Poly-urethane	8.0	6- 8	*$162	SZ3D 207
4	III	Zinc Chromate Primer	Metal Prot.	Metal Prot.	6.0	6- 8	*$155	SZ3D 217
5	II	Inorganic Zinc Primer	High Build Epoxy	—	8.5	5- 7	*$139	SZ3D 197
6	II	Inorganic Zinc Primer	High Build Poly-urethane	—	7.0	8-12	*$136.50	SZ3D 228
7	II	Epoxy Primer	High Build Epoxy	—	8.0	4- 6	*$ 94.50	SZ3D 202
8	II	Epoxy Primer	Epoxy Enamel	—	4.0	2- 3	*$ 90	Design Spec. 109PP
9	II	Epoxy Primer	—	—	2.0	8-12M	*$ 45	Design Spec. 171A
10	III	Zinc Chromate Primer	—	—	2.0	8-12M	*$ 45	Design Spec. 170B

≠ Actual price provided by Owens Steel Co., Columbia, SC; 4/22/76.

* Prices furnished by F&F-Wilmington from local contractor and surface preparation is not included. These are only material and labor to apply; 4/22/76.

** Average surface area of steel = 225 sq.ft. per ton.

Being the highly industrialized country we are and having high-cost labor, it sure reflects to our coatings systems. Eighty percent of all coating failures are caused by improper surface preparation, application procedures, lack of inspection and/or supervision.

So, a determining factor is the cost of labor versus the cost of capital. Galvanizing is a capital-intensive process with a high proportion of fixed costs. Painting, by contrast, is labor intensive. In locations where labor costs are high and capital costs low (Middle Atlantic States, Mississippi Valley), galvanizing will be more attractive than where the labor rates are low and capital costs are high (Mexico, Iran, Houston, etc.).

This factor of economics choice becomes more dominant when one compares discounted cash flow analysis. Higher interest rates will discourage the investment in 20- to 30-year coating systems in favor of frequent painting which would utilize low-cost labor. Low interest rates lead one to invest in long-term coating systems, and higher labor rates favor galvanizing over other coatings.

The entire economic analysis depends on the end objectives and standards to be achieved. What service life is required? What appearance? What safety standards must be met?

In most atmospheric noncorrosive environments, 3 to 5 mils dry film thickness of zinc on hot-dip galvanized steel will be protected for 20 years or more; topcoating the galvanize when needed with the proper painting system at the proper time may double its life.

On the other hand, topcoated galvanized steel would be a poor choice if the total anticipated life of a structure is two or three years. If appearance is not critical, this structure should not be coated at all.

Needless to say, the Protective Coatings Standards Committee spend many hours of work, research, and study on our Standards SN1D, "Coatings Systems for Noncorrosive Areas", and SN2D, "Coatings Systems for Corrosive Areas", over this past year.

Recommendations are as follows:

- Noncorrosive areas -- do not coat galvanized steel.
- Coatings systems shown are for existing weathered galvanize, for decorative painting, or for repair of damaged areas.

In corrosive areas, per paragraph 4: "Galvanized steel is not recommended for new installations where additional protection is needed for exposure. Experience has shown erratic and unpredictable coating adhesion to new galvanized steel without special surface preparation or treatment."

It is recommended that in corrosive areas such as pigments plants (for example, Johnsonville, Edge Moor) structural steel should be purchased requiring a minimum surface preparation of SSPC SP-6 primed with Ganicin® inorganic zinc. Intermediate and topcoats to be selected and added, depending on the corrosive condition, in the field either before or after erection.

On existing plants or remodeled areas where galvanized steel will be located in a corrosive area, brush-off sandblast; on a clean, dry, aged galvanized surface, epoxy paint is the recommendation.

To briefly recap, key words and phrases to remember are:

- initial costs
- coating life
- repaint cycle
- repaint cost
- inflation
- corrosive
- noncorrosive
- proper complete painting system.

IN NONCORROSIVE AREAS DO NOT PAINT GALVANIZED STEEL.

IN CORROSIVE AREAS DO NOT PURCHASE GALVANIZED STEEL ON NEW CONSTRUCTION. PURCHASE STRUCTURAL STEEL EPOXY PAINTED.

CHANGES IN PROTECTIVE COATINGS STANDARDS

D. W. Ferguson

Since the SZ section of Standards was formed in 1955, many efforts have been made to improve its usefulness.

This effort began when the first standard, SZ1A, "Sectional Guide, Protective Coatings", providing the original outline for the organization of the Protective Coatings Section of Standards, was written. This guides the user through coatings selection, surface preparation, products and coatings for specific items.

During 1971, Fred Thompson, the former Subcommittee Chairman, and I met with R. L. Klausmeier, who was then Assistant Standards Manager, and reviewed the organization of the SZ section, detailing what steps had to be taken by the user to develop a protective coatings specification for a specific application. As a result of this meeting, SZ3A, "Procedure for Use of Protective Coatings Section of Standards", was written. This was the second effort and went into some detail regarding job analysis and specification preparation including several examples.

Early in 1974, the Standards Section initiated development of a self-instruction course to help someone who is not knowledgeable in this area to use the SZ section of Standards. This action was taken after comments from the users indicated most of the people who were seeking information in this area did not have sufficient background to understand the existing system. During review of the instruction course developed by Bill Hitchens, it became evident that in many cases the user was given two or more recommendations with little or no guidance as to which coating system he should specify. Then, to further confuse him, when he finally selected one of the systems from either SZ1D or SZ2D, there was a good chance the system listed in SZ3D would start with a metal primer that was not identified. For primer selection, the user was referred to the metal primer chart which was located on Page 6 of the earlier version of SZ3D. Then, based on substrate, its condition, and other information, he attempted to select a primer that was compatible with the substrate and the top coats which would be applied over the primer. As you can see, someone who is not very familiar in this area would have an opportunity to make many mistakes.

Hopefully the revised versions of SZ1D, SZ2D, and SZ3D, supplemented by the updated product list, SZ1E, can be used by people who are not familiar in this area to specify coating systems which will be adequate for most applications. However, as in the past, when making recommendations for a very large job when no previous experience is available, it is advisable to seek assistance of a specialist in this field.

Let's take a look at the new Standards (May, 1976) and review the changes made to improve communication with the user.

We will begin by reviewing Section 3 of SZ1D, "Coatings for Noncorrosive Areas", which guides the use of Selection Tables 1 and 2. In Table 1, covering selection for outdoor exposure, under the heading "Substrate", the user is required to identify the substrate of the item to be coated; in this case let's say it is steel. Second, note "Item to be Coated"; for this example let's say structural steel. Next, determine the substrate condition prior to application of the primer or the first coat. Under the heading "Substrate Condition", you have a choice of two substrate conditions: (1) blast cleaned, Class II on which a primer that will dry in 16 to 24 hours is included in the system or (2) a Class III, hand-cleaned or brush-blasted surface which is designed to handle a primer that will dry in 24 to 36 hours. Next, you will have to determine the degree of gloss desired and the type of coating, if this is important. These are listed under the heading "Type of Finish". Finally, note the system number adjacent to your selection. Let's say you decide to coat your Class II, blast-cleaned structural steel with a semi-gloss alkyd finish and can live with the 16- to 24-hour drying time listed for the primer. Note that System 211 is recommended.

Section 3 then directs you to carry this number into SZ3D for the make-up of the system. On page 4 of SZ3D you will see System 211 listed near the center of the page. System 211 specifies one coat or 2 mils of 373-851 Rust-Resistant Red Lead Primer, Engineering Number 1040, and two coats (or a total of 4 mils) of 25-Line Dulux® Metal Protective Paint. The Engineering Number series for the 25-Line coating is 5100-5199. The exact number will depend on the color selected.

Please note that each one of the systems is now tied to a substrate with a fixed condition which makes it possible for the Subcommittee to specify a primer that will be compatible with the substrate surface preparation and, of course, the top coat. In addition, the user is told how many coats normally will be required to attain the dry film thickness specified.

During review of the 11 pages of recommendations for corrosive areas contained in SZ2D, the Subcommittee discovered that many of the systems recommended were repeated. With this in mind, an ad hoc committee was directed to try to develop a single set of recommendations that would provide protection for most corrosive areas. To establish this standard set of recommendations, the systems selected necessarily make some minor compromises and in some cases are better than required for the exposure. Some may not be the single best system available for each application, but they will do an adequate job, reduce paint inventories, and simplify application.

Now let's look at the results of some of this work as it is presented in SZ2D. You will note the 11 pages of recommendations have been reduced to a simple table on page 3 of the revised specification. Instructions for use of this table are given in Section 3 and state: "For specific exposure involved, refer to the Chemical Exposure Index, Table 1", which is on page 2. Second, the user is asked to note any exceptions in the table and then proceed to Table 2. Before leaving Table 1, note the double asterisk after nitric acid. The user is told that above 28% concentrations, paints are not recommended for splash and spill exposures. The only other exceptions are the single daggers shown after cyclohexane, cyclchexonal, and cyclohexone which tell the user that the system recommended for outdoor exposures should be used for both indoors and outdoors and the double dagger following dimethyl acetate and dimethyl formamide which informs the user that he should use a Class II surface preparation and finish with System 148. In addition, the user is told that applications for chemical exposures not covered in Table 1, he should seek the assistance of a specialist in the field.

Now let's take a look at our simplified Table 2. Under the heading "Substrate", iron and steel, galvanized steel (exposed, no rust), galvanized steel (exposed, rust spots or stain with zinc remaining), concrete block, and concrete and masonry are listed. Under the heading "Surface Preparation", we have listed the SZ1B class number or reference section and, for the first time, an equivalent SSPC specification. The heading "Splash, Spill, and Fumes" is divided into both indoor and outdoor exposures and,also for the first time, the note following the dagger defines "splash and spill". This is defined as "infrequent, unintentional, or accidental spills". It does not cover continuous leaks or periodic overflows. Where design anticipates these latter conditions, alternate materials of construction should be considered. Also, note the asterisk tied to galvanized steel which tells the user that "Galvanized steel is not recommended for new installations in corrosive areas where additional protection is needed for the exposure. Experience has shown erratic and unpredictable coating adhesion to new galvanized steel without special surface preparation or treatment." If the exposure is listed in Table 1 and none of the exceptions are applicable, the user is then sent to SZ3D for description of the individual systems. If it is not listed, he is advised to consult a specialist in the fiedl.

The Subcommittee hopes that issue of these revised Standards will eliminate the need for the programmed instruction course and errors resulting from misapplication of the information in the earlier versions.

NEW PAINT EVALUATION TEST

J. R. Allen

In discussions with F&F personnel, we expressed limited confidence in salt spray tests to consistently produce results indicative of field performance of industrial maintenance coating systems. However, it is widely used and convenient for laboratory testing.

In our experience on the plants we had observed that pipe and equipment that periodically sweat and dry represent severe service in which many coating systems fail rapidly. We and F&F agreed that this would be an interesting condition to incorporate in a laboratory test. Bob McCormick and I have designed and built equipment at the Engineering Test Center to explore this idea. It is not in operation yet, but samples and equipment are just about ready for start-up.

Since we're just checking an idea, we wanted to keep cost to a minimum. The equipment consists of a cabinet in which we have a humidifier and a control and soil cable for heat. Arrangement accommodates exposing 14 test sections of 2-inch pipe horizontally (18-inch lengths). These are incorporated into a piping system connected to a supply of Zerex® in the freezer at one end of the cabinet.

For the first run, several different types of coating systems over as-fabricated pipe, hand cleaned and blast cleaned, will be exposed. Scribe damages in the coatings will be employed to indicate spread of corrosion from a break in the paint system.

For the sweating cycle, we will establish a warm and humid atmosphere in the cabinet and pump chilled Zerex® through the pipe. For the drying cycle, this will be discontinued and the cabinet heated to a warm, dry atmosphere. This procedure will be repeated and, hopefully, in not too long a period of time we will detect differences in performance of the different coating systems.

Guided by field experience, we have selected coating systems that should vary in performance.

If this approach does not produce meaningful results sufficiently rapid, it may be necessary to create more extreme conditions such as cooling to the point of frost formation and drying by pumping a heated liquid through the pipe.

TOUR OF CHAMBERS WORKS

L. C. Jennings, R. Shiles, R. DeWitt

Chambers Works is located on a site containing about 500 acres. The plant is crossed with about 15 miles of standard gauge and 12 miles of narrow gauge railroad track. Approximately 6,000 people work in the 500 or so buildings on the plant which has been here for 60 years.

Orchem's major research and development laboratory and two of its sales service laboratories are on the site. In addition, the Elastomer Chemicals Department operates facilities here, and the Engineering Department has installed permanent facilities for its Construction Division.

Tour

Intermediates awaiting further processing are stored in the corral on the right.

In the Chemicals Area buildings on the right, a variety of surfactants, repellents, and miscellaneous specialty products are produced.

Across the corner is a building in which organic titanates are produced. Also in that building, fuel additives are blended for shipment using automated liquid blending equipment.

The Administration Building on the right provides offices for Plant Management and many of our engineering and accounting people.

Beyond the bridge to the left is a power plant from which we obtain electric power, steam, and river water.

The canal provides fresh water for the plant. The dam stores it and prevents contamination with brackish river water.

Canal water is treated in the purification plant on the right.

Buildings in this area are part of Jackson Laboratory, our R&D Division. The main building on the right contains offices, laboratories, computers, library, and pilot facilities. On the left is the Process Development Laboratory.

The small building on the left at the bend in the road is the river cafeteria, one of two cafeterias on the plant.

River Road

On the left is the Dyes and Chemicals Technical Laboratory, operated by the Dyes and Chemicals Sales Division to give technical assistance to their customers. It is equipped with a variety of equipment typical of that used in the industry, including one of the world's smallest paper-making machines.

The building on the right has offices and laboratories for some of the technical people who are in dye manufacturing activities.

Behind that building and ahead on the right are facilities of our Development Manufacturing Area. New processes can be piloted in these facilities and small-volume production runs made. Most of our products had their commercial start here, including everything from Adiprene® to Zepel®. A fluorocarbon distillation set can be seen at the road end of the corner building, and beyond that is equipment for blending Freon® products.

On the left is the Firehouse. Beyond it is the Medical Building which is prepared to cope with emergencies but has as its major activity the giving of annual physical exams.

Fire Road

On the left are facilities for manufacture of tetraethyl and tetramethyl lead. Because of the toxicity of these products, they are manufactured under very carefully controlled conditions in highly sophisticated facilities. Both continuous and batch processes are employed; one of the batch process buildings is completely computer controlled.

Turning down Main Road, the sulfuric acid plant is visible to the left. This is a contact plant, burning molten sulfur and catalytically oxidizing the sulfur dioxide to sulfur trioxide (silicone aluminum trombone).

Azo Road

The tall buildings ahead to the left are the Azo Dyes Buildings. Most processes in the buildings are batch and are run in aqueous solvents. A very modern ice-making machine is located in the penthouse. Ice flows by gravity to the reaction vessels. Most azo dyes are used in textiles or paper. Other dyes, including those used in ball pen inks, are also make in these buildings.

The Azo Laboratory is on the right. To the left is the building in which crude dyes are ground and mixed to produce the final standardized product.

Garage Road

The low white building provides office space for Dyes and Chemicals production supervision.

DUP 101043O

Broadway

The Computer Center is on the right at the corner. The plant's IBM 360-65 computer is located there. Across the parking lot to the left, the Basic Dyes, Crystal Violet, and Magenta Buildings can be seen. The dye Crystal Violet gives the purple color to ditto copies. A variety of other dyes are also produced in these facilities.

Kinetic Road

Turning onto Kinetic Road, the plant cafeteria is on the left. Behind it are facilities used in making intermediates. Fluoroalcohols are made in the large green structure. The tall columns are used primarily for isomer separation. Some isomer separation is also accomplished by fractional crystallization using a process called "sweating".

The old building to the right at the corner is the Intermediates Laboratory and Office. Beside it is the General Analytical Laboratory which serves this entire section of the plant. Samples are sent to the laboratory in a pneumatic tube system connected to each building.

To the left are continuous and also batch facilities for nitration. To the right is a large continuous dinitrotoluene plant, controlled from the low green building. This process features large automatic centrifuges which separate two liquid phases and some solids.

Textile additives are produced in the building to the left beyond the batch nitrator. Behind it can be seen the Hydrogen Reduction Building in which catalytic hydrogenations are performed under pressure, primarily in batch autoclaves.

Diamines-Kevlar® Plant

Nomex® nylon intermediates are produced in the large-scale continuous plant on the right. When polymerized and spun at another Du Pont plant, they yield a heat-resistant fiber used in protective clothing by workers on our plant as well as by race drivers, pilots, etc. The column is one of the tallest on Chambers Works. Processes and facilities are quite sophisticated in this operation.

Miscellaneous Stores is on the left.

Now we come to the HF Manufacturing Area and to the Freon®-113, -114,-115, -11, and -12 Manufacturing Plant.

Turning left, then right along the river, we pass the ethyl chloride scrubber and Imron® Blue Hortonsphere.

Next are the molten sulfur storage tanks where we can get a good look at a Thermacon job (aluminum and isocyanurate insulation).

Turning left and returning to River Road, we see an Imron® oleum tank (over mastic).

Sulfur Road

The buildings to the left were initially erected to produce sulfur dyes by batch processing. A variety of dyes and intermediates are produced there now.

The buildings on the right produce various intermediates. The green-sided wing contains equipment used in preparing ethylene oxide adducts by a batch process which is automated using sequential tape controls. Within this complex of buildings, many unit processes are operated -- sulfonation, nitration, amination, caustic fusion, iron reduction, etc.

At the right end of the building across the tracks beyond the stop sign is equipment for nitric acid oxidation of a substituted toluene to the corresponding acid.

(Coffee Break)

Fire Road to Neoprene Road, pass nitrators, Elastomers Area.

Left at Sandblast Road, pass Sandblast to Waste Treatment Plant.

Ponsol® Road

The interesting one-story building on the right is the office and laboratory of the Elastomer Chemicals Department. To the left is the salvage yard of the plant.

The green and silver building well back to the left is the Cube Shop. The Engineering Department Construction Division preassembles items in this building and then moves them to the construction site for installation. The technique is called "cubing".

On the right is one of the best equipped pipe shops on the East Coast. It has wide capability for fabricating pipe to unusual shapes.

The Petroleum Chemical Sales Service Laboratory is on the left. It has facilities for testing fuels and fuel or oil additives in a variety of engines and use conditions. Interesting studies on combustion have been undertaken here. The Thermal Exhaust Reactor for automobiles was developed by this group.

DUP 1010432

Ponsol® dye manufacture is concentrated in this location, primarily in the large building across the corner to the right. These processes are primarily batch operations in nonaqueous systems. The corrosive environment of these processes requires the use of a wide variety of materials of construction. The manufacture of some of these dyes is so intricate that they are in process for months from start of synthesis to standardization of dye. Boxes of wet dye press cakes are frequently visible on building platforms. From there, they are moved to the dry house, located to the left down Broadway.

<u>Broadway</u>

To the left, the very large Consolidated Warehouse can be seen. It occupies 6-1/2 acres and is well automated for materials handling.

TRENDS IN OSHA REGULATIONS

R. D. Richardson

Introduction

- Occupational Safety and Health Act of 1970 (December 29):
  - "to assure, as far as possible, safe and healthful working conditions to every employee in America and to preserve this country's humas resources."
- Hailed at the time:
  - by Congress as "a bill of rights".
  - by the President as "an example of the American system at its best."
- The reality has not yet lived up to the promise:
  - $2-3 billion has been spent on mandatory OSHA compliance without any clearly demonstrated improvement in industrial safety records.

    (General agreement on this statement by industry, labor, and governmental officials including The White House.)
  - It is claimed that each year there are 14,000 to 15,000 deaths from job-related injuries and 300,000 to 400,000 new cases of occupational disease.

    (Ironically, as a result of the improved accident reporting methods set up by OSHA, more injuries will be reported -- with a consequential adverse effect on OSHA's apparent performance in preventing injuries. Further, as a result of publicity and education, more physicians and workers are recognizing certain diseases and ailments as being work related.)
- This poor record is despite the fact that between inception (April 28, 1971) and the end of January, 1976, there had been:

  289,794 inspections, leading to
  205,215 citations, alleging
  1,073,217 violations

  - These led to proposed penalties of $27,628,001.
  - There are currently over 9,000 inspections per month.

DUP 1010434

- The primary emphasis during the first five years of OSHA has been on safety.
  - 90% of OSHA's current 1,300 compliance officers are safety inspectors.
- It is no secret where the next emphasis will fall:
  - In February, W. J. Usery (now Secretary of Labor) told the Senate Labor and Public Welfare Committee that OSHA should emphasize health.
  - Morton Corn (Assistant Labor Secretary) stated publicly that for the next two years all hires of the agency will be health compliance officers, increasing the number of health compliance officers from the present 135 to 1,000.
  - Also in support of this function, he is creating a technical support arm which will include an analytical laboratory capability; an engineering group to handle technical aspects of engineering controls and to aid in establishing realistic abatement schedules; a toxicological referral center will be established to assist the health compliance officers.
  - Similarly, many states (e.g., New Jersey and California) have announced that occupational health now holds top priority in their safety and health programs.
  - Labor, too, is demanding more action. AFL-CIO recently called for 640 new jobs in OSHA, a significant proportion being for industrial hygienists.
- To provide teeth for the OSHA attack on occupational health problems, several new standards have been promulgated or proposed:
  - OSHA has issued 18 standards for "Toxic and Hazardous Substances" since October, 1972.
    - 15 chemicals are treated as "cancer suspect" (remaining three: air contaminants, coal tar pitch volatiles, asbestos).
  - There are over 100 additional standards currently in preparation, with the prospect of 200 to 300 to follow.
  - Proposed standards in advanced stages of preparation: 8 safety, 13 health (11 specific chemicals), including, for example, lead, toluene, noise.

- Standard Completion Project 1910.1000:
  - "Mini" standards proposed: 96 health (96 specific chemicals) including ketones, esters, ethers, petroleum distillates, turpentine, styrene.
- NIOSH Criteria Documents issued: 29 (26 specific substances) including chromium VI, asbestos, silica.

Specific Substances of Interest to Painters and Insulators

Asbestos

- Phased out as lagging component in Du Pont since 1972 but will take 10 to 15 years to eliminate.
- Public and worker interest will continue to increase with adverse publicity.
  - Asbestos causes asbestosis, a nonmalignant scarring of the lungs; broncogenic carcinoma, a malignancy of the interior of the lung; mesothelioma, diffuse malignancy of the lining of the chest cavity (rare in general population); cancer of stomach, colon, rectum.
  - Estimated 40M-120M asbestos workers will die from lung cancer. An asbestos worker who smokes is at eight times the risk of a smoker who does not work with asbestos.
  - Major lawsuits pending against asbestos producers.
  - Chambers Works experience good; no known health effects on employees.
  - Neighboring (non-Du Pont) plant union reports that of 59 insulators employed since 1954, seven died with cancer, five are retired with cancer, six died from heart attacks, nine retired with disabilities, and nine are still working with disabilities.
  - Buildings in which asbestos used instead of concrete as the fire-retardant wrapping on steel beams (since 1959) may contain hazardous levels of asbestos in the air (claimed).
  - Du Pont Engineering Standard, issued April, 1973, reaffirmed July, 1975, embodies the OSHA requirements; but note that on July 1, 1976, the permissible limit for the number of fibers of length >5 microns is reduced from 5 to 2/cc for an eight-hour day. New proposal would reduce the limit further to 0.5/cc and reduce the present ceiling value of 10/cc to 5/cc.

DUP 1010436

- OSHA extended rule requiring records of worker exposure to be kept for 20 years (was three years) on March 19, 1976.
- Move by unions to have statute of limitation on all occupational diseases increased due to latent period for development of some diseases.

- Asbestos replacements: chronic toxicological properties are largely unknown. These substances should be handled with caution. (See Archives of Environmental Health, March/April, 1976; pages 101-107.)

  NIOSH criteria document of fibrous glass is being prepared; date of issue is uncertain.

Chromium

- In December, 1975, NIOSH proposed two standards for Chromium (VI):
  - Noncarcinogenic Chromium(VI) - e.g., alkali metal mono and bichromates.
  - Carcinogenic Chromium (VI) - most others, including lead chromate.
  - Proposed TWA:

    Noncarcinogenic Chromium(VI) - 25 $\mu g/m^3$ as Cr(VI) (ceiling 50 $\mu g/m^3$)

    Carcinogenic Chromium(VI) - 1 $\mu g/m^3$ as Cr(VI)
  - Present TWA: 100 $\mu g/m^3$ as CrO_3

  The projected date for issue of a final standard for Cr(VI) is November, 1976.

  The United Steelworkers of American have requested that an emergency temporary standard be issued promptly.

- Zinc and lead chromates were designated suspect carcinogens by the General Manager and Vice President of the Pigments Department on April 30, 1975.

  A later report from the Dry Color Manufacturers' Assocation's Lead Chromate Task Force to NIOSH prompted NIOSH to issue an alert on August 22, 1975, on possible carcinogenicity in humans from exposure to chromates. Preliminary indications are that deaths due to lung cancer are three to four times greater among workers exposed to lead chromate than with the general industrial population.

DUP 1010437

- Chambers Works has adopted mandatory procedures for spray painting and abrasive cleaning chromate paints, for field and permanent booth operations. Key elements include restricted area, protective equipment, medical surveillance, and record keeping.

- Air monitoring in the vicinity of field and permanent booth operations on Chambers Works for spray painting and abrasive cleaning has shown Cr(VI) levels to be at satisfactory low levels in all surrounding areas where respiratory protection is not required.

- The need for good ventilation and an approved respirator for spray painting in a booth is demonstrated by the following data (J. R. McCarthy, Chambers Works, 1976):

	Micrograms(1) CrO_3 in Saliva		Micrograms(1) CrO_3 in Saliva
VENTILATION 60 fpm(3)		VENTILATION 60 fpm	
Painter with approved respirator(4)	0.00	Painter with non-approved respirator(5)	0.23
Observer without respirator	0.00	Observer without respirator	0.43
NO VENTILATION(6)		NO VENTILATION	
Painter with approved respirator(4)	0.04	Painter with non-approved respirator(5)	4.91
Observer without respirator	1.10	Observer without respirator	7.70

(1) Air monitoring data showed concentration of CrO_3 in air to be:
(a) with 60 fpm ventilation 4.8 mg/m^3
(b) with fan off 20.1 mg/m^3
(sample time: 3 minutes)

(2) No air monitoring data available.

(3) Chambers Works has since adopted a minimum standard of 100 fpm.

(4) Willson #122114 double cartridge R-14 and R-21.

(5) Willson #541 single cartridge.

(6) Fan off.

Paint: Corlar® No. 825-8031 (zinc-chromate type).

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Silica

- In November, 1974, NIOSH recommended limit 50 $\mu g/m^3$ for crystalline silica.

- Present ACGIH TLV depends on the respirable quartz content ($<5 \mu m$) and the formula will yield a value of $\geq 100 \mu g/m^3$. There is also a TLV for total dust, dependent upon the quartz content and this formula will yield a value of $\geq 300 \mu g/m^3$.

- Crystalline quartz causes pulmonary fibrosis.

- Hal Fernandez, Engineering Department, recently conducted a special survey of the operations at Chambers Works Sandblasting Yard. It was concluded that personnel engaged in sandblasting are adequately protected but that a containment program is necessary to prevent contamination of neighboring areas. Specific recommendations are being prepared.

Solvents

- Many solvents and other components present in paint and coatings compositions may be subject to the mini-standards being issued under the Standards Completion Project, and others may warrant individual standards of their own. Examples include ketones, esters, ethers, petroleum distillates, turpentine, styrene.

  Although the standards have not been promulgated into law yet, the period which the law requires for comments from interested parties to OSHA on proposed standards has already expired for many substances.

- The proposed standards would establish requirements for measurement of employee exposure, medical surveillance, methods of compliance handling and use of liquid forms of the substance, employee training, record keeping, and sanitation and housekeeping among other things.

- The proposed standards are comprehensive and generally are based on sound, well established safe work practices. There are enough deviations from standard Du Pont practices, however, that total compliance would result in a sizeable cost penalty. Although most of these additional requirements are technically feasible, their need is not immediately apparent.

- Some of these new proposed requirements and unexpected features are:

  - Introduction of the action level concept (action level is 50% of TWA value).

    Three key duties are triggered by exceeding the action level: exposure measurement, medical surveillance, and employee training. Important to operate at below action level to minimize impact of standard by avoiding some

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requirements of the standard. (The intent of each standard is to safeguard the health of each worker and to maximize the probability of this to force each employer to operate at below the action level. Further, as will be emphasized later, this will be achieved when feasible by engineering controls with a minimum requirement for personal protective equipment.)

(a) <u>Exposure Measurement</u>

Below action level - written determination (calculation required and recorded. Actual measurement may also be made.

At or above action level but below permissible level - exposure of each employee shall be measured at least every two months (latest proposed standards, say, three months). Latest NIOSH Criteria Document on which proposed standards may be based specify number of determinations of breating zone exposures (e.g., less than 20 workers, 50% of number of workers; 20 to 100 workers require 10 + 25% number of workers over 20).

Above the permissible level, early proposed standards state: measure exposure monthly and

- institute control measures to reduce exposure below the permissible level, and
- individually notify, in writing within five days, every employee found to be exposed above the permissible exposure. The employee shall also be notified of the corrective action being taken to reduce exposure.

Above the permissible level - latest NIOSH criteria documents state environmental concentrations shall be reduced by suitable engineering controls. Exposures shall be monitored at least weekly until the effectiveness of the controls is established. Also, all records of sampling and of pertinent medical examinations shall be maintained for at least 20 years after the individual's employment is terminated.

Employees (or their representatives) are entitled to observe any measurement of exposure, to receive a full explanation of the procedure and to record the results obtained.

(b) Medical Surveillance

The physician must check the employee's medical history to determine whether the employee is at risk (relative to an employee in normal good health) if he were to be exposed to the toxic substance.

A medical examination must be given if there is reason to believe the employee is at increased risk or if he informs the employer of any medical symptoms which may be attributable to or aggravated by exposure to the toxic substance. In this situation the examining physician must provide a written statement on the suitability of the worker to work with the specific toxic substance. OSHA does not require that the worker submit to a medical examination; but if he refuses, then the employer shall obtain a signed statement from the employee indicating he understands the risk involved by refusal to be examined.

Du Pont requires employees to undergo medical examination as a condition of employment.

(c) Employee Training and Information

Each employer is required to:

- keep a copy of the regulation at the workplace available to employees.
- annually hold training sessions to:
  - review data in the Safety Data Section.
  - advise employees of the signs and symptoms of exposure to the substance and require employees to report these if they become evident.
  - review emergency procedures, correct use of protective equipment, etc.

- Some other features of the proposed standards and criteria documents:
  - Compliance with the exposure limits shall be met by engineering and work practice controls. Whenever "feasible" engineering and work practice controls are not sufficient to reduce exposure to at or below the permissible exposure, they shall nonetheless be used to reduce exposure to the lowest level feasible and shall be supplemented by respirators.

    Compliance with the permissible exposure shall not be achieved by the use of respirators except:

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  - during the time period necessary to install or implement engineering or work practice controls, or
  - in work situations in which engineering and work practice controls are technically not feasible; or
  - to supplement engineering and work practice controls when such controls fail to reduce airborne concentrations to at or below the permissible exposure; or
  - for operations which require respirator use for not longer than one hour per day and not more frequently than one day per week; or

    (Note this exception does not appear in some later standards and criteria documents.)
  - in emergencies.

- Respirator criteria are more stringent than current practice; for example:
  - carbon cartridge masks not permitted in certain cases (e.g., carbon tetrachloride).
  - self-contained breathing apparatus must have the pressure demand (positive pressure) mode action.
  - air-supplied respirators must have an independent "escape bottle" feature.
- Record keeping:
  - Requirements defined for keeping records of:
    - exposure determination
    - exposure measurements, including information on sampling and analytical methods
    - identity of employee monitored
    - mechanical ventilation
    - medical surveillance
  - All records are to be available on request to authorized representatives of the Assistant Secretary of Labor for OSHA and the Director of NIOSH. Some records are to be available on request to employees, past employees, their designated representatives, and their physicians.

Cost of Compliance

- Precise cost estimates for compliance with proposed standards are not possible. However, a recent Company-wide survey was made to estimate the economic impact of the OSHA "400" Mini-Standards (Standards Completion Project 1910.100) on the Company. This high-spot estimate indicated a projected additional cost of:

	Initial Outlay $MM (1975)	Annual Operating Expense $M (1975)
Du Pont	23	18.5

It should be noted that the OSHA "400" list is only a partial listing of the chemicals we handle and that future standards for other chemicals and potential physical hazards are certain.

Some General Trends and Predictions

- Level of new legislation is not likely to diminish near term.
  - Public interest in workplace and environmental quality is high. Interest is being fanned by special-interest groups and extensive reporting by news media.
  - Track record of industry is less than perfect; e.g., kepone, vinyl chloride, polybromobiphenyls, polychlorobiphenyls.
  - "Public" concern leads to legislation. Unfortunately, legislation has moved ahead of the state of the art which permits a precise scientific definition. (Examples include setting safe exposure limits for toxic substances; banning of cyclamates, TEL, Food Red 2 dye.)
  - Governmental agencies (e.g., OSHA, EPA) have been granted broad discretionary powers in writing, enforcing, and interpreting regulations.
- New regulations will continue to reflect the trend to stricter standards.
  - "Maximizing occupational opportunities for all workers means minimizing the workplace hazards not only for the minimally susceptible worker but for the highly susceptible worker. This means that even pregnant women and blacks who carry the sickle cell anemia trait must be permitted to work in an environment safe from health hazard. The permissible levels of exposure to hazardous materials must be kept sufficiently low in the workplace so as not to endanger those highly susceptible." (Benjamin Mintz, Assistant Solicitor, DOL; April 8, 1976)

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This is a significant departure from the traditional concept of operating below the threshold limit value (TLV) for worker exposure. By definition, TLV's refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed day after day without adverse effects.

- Revision of penalties for infractions of OSHA standards is very probable.
  - Under existing laws, one may be liable for penalties of:
    - $250M for one line of false advertising.
    - $1M for a fatality on the job (a serious offense carries a maximum penalty of $10M).

  (B. Fellnen, Office of the Solicitor, March 18, 1976; Benjamin Mintz, Assistant Solicitor, DOL, April 8, 1976.)

- OSHA may price states out of role in job safety and health.
  - The cost associated with the high degree of technical sophistication required to police industries and the high volume of required inspections will prove prohibitive to most states. This will make the Federal Government an even more dominant factor in workplace safety and health.

- OSHA, unable to provide convincing evidence to date of its positive influence in reducing occupational accidents, will have even greater difficulty in demonstrating a positive influence in reducing occupational health problems.
  - Most major occupational health problems today are of a chronic (long-term) nature.
  - NIOSH recently announced plans for a comprehensive program of surveillance, industry-wide studies, and laboratory research aimed at reducing new cancers of occupational origin by 10%. As occupational cancer probably accounts for 2% to 5% total cancer, and as the latency period for development of cancer may be commonly 10 to 30 years, then the benefit of the program, though worthwhile, may be difficult to prove.

- OSHA has restated its policy of focusing on target industries.
  - Early target industry was the maritime industry with a notoriously poor safety record. Recent OSHA inspection statistics show that 48% of maritime establishments are in compliance versus 21% for manufacturing.

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- In November, 1975, OSHA announced another target industry or group of industries. Under the National Emphasis Program, OSHA will commit 5% to 7% of its enforcement personnel to inspect 5,200 firms in the iron and steel foundries and the aluminum, bronze, brass, and copper casting and metal stamping industries. This special compliance effort "will prove whether the philosophy behind OSHA is valid". (Barry T. White, Associate Assistant Labor Secretary)

- Chemical industry to become target industry on health inspections. (Morton Corn, Assistant Secretary of Labor for OSHA, March 1, 1976)

  - Du Pont experience with OSHA inspections generally favorable to date (March, 1976):

Total inspections 1971 to March, 1976:	145
Total inspections 1975:	37
Total inspections Jan. to March, 1976:	15

    We can forecast with absolute certainty OSHA inspections of Du Pont facilities will increase.

<u>Summary of Trends</u>

- More legislation, with many more standards to issue.
- Standards to issue will have broader impact on the chemical industry than those previously issued.
- Standards will be stricter in some respects than those currently practiced by industry leaders.
- Greater emphasis on engineering and work practice controls to achieve a safe working environment.
- Restrictions to be placed on use of personal protective equipment to achieve compliance with air quality requirements in the breathing space during normal operations.
- More workplace environmental monitoring required.
- More formal employee training on potential occupational health hazards required.
- More medical surveillance requirements.
- More record keeping required.
- Heavier emphasis by OSHA on elimination of occupational health problems with no dimunition of attention to safety aspects.

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- More frequent inspections of chemical plants, including Du Pont.
- More stringent penalties for serious violations likely.
- Occupational safety and health standards and enforcement to become increasingly the province of the Federal rather than state governments.
- New standards on chromium and solvents due late 1976. Asbestos and silica are not scheduled; unlikely before 1977.

Final Cautionary Note

The preceding comments are based on trends apparent in proposed regulations and comments by Department of Labor personnel. It should not be assumed that the final standards which are promulgated into law will follow these trends precisely.

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