

PROTECTO 401

**THE PROVEN CERAMIC
EPOXY LINING.**

BACKGROUND

In 1979, Induron Coatings, Inc. began the two-year research and development process that led to the industry-leading product known as Protecto 401™ today.

The first Protecto 401™-lined ductile iron sewer pipe was placed into service in 1981. Since then, literally thousands of miles of ductile iron sewer pipe have been lined with Protecto 401™.

PRODUCT QUALITIES

Specifically designed to protect ductile iron sanitary sewer pipe, Protecto 401™ Ceramic Epoxy Lining provides the reliability of cement mortar lining with the unequalled corrosion protection of novolac epoxy. Its unique qualities have resulted in performance unmatched by any other lining.

PROTECTING YOUR PROJECTS. AND YOUR REPUTATION.

Over the years, Protecto 401™ has been exhaustively tested and evaluated—both by Induron's own Research and Development professionals, and in independent laboratory settings.

To further protect your ductile iron sewer pipe projects, Induron allows no deviations from our strict testing and application specifications without our prior written approval. All third party inspections are conducted using Induron's standard Protecto 401™ Ceramic Epoxy Quality Control Procedures.

APPLICATION AND SPECIFICATION OVERVIEW

Protecto 401™ is applied to the interior of ductile pipe and fittings, utilizing specialized application equipment and stringent specifications. The lining is designed to be applied at a nominal 40-mil thickness. A nondestructive pinhole detection test, and a thickness test, are performed to insure a sound, chemically-resistant protective lining for ductile iron pipe and fittings.

PROTECTO 401

**THE PROVEN CERAMIC
EPOXY LINING.**

Nothing protects tough sewer pipe applications more effectively than ductile iron pipe and fittings lined with Induron's Protecto 401™ Ceramic Epoxy. It's been successfully used in hundreds of sanitary sewer applications and proven both in laboratory testing and decades of actual sewer service.

Since 1981, literally thousands of miles of ductile iron sewer pipe have been lined with Protecto 401™. Give your projects and your reputation the protection they deserve. Specify ductile iron pipe and fittings lined with Protecto 401™.

QUALIFIED UNDER:

ASTM E-96 ASTM G-95

ASTM B-117 ASTM G-14

ASTM D-714 ASTM D-

1308 ASTM G-22 ASTM

FI476-95A EPA 1311



PROTECTO 401

THE PROVEN CERAMIC EPOXY LINING.

protecto401.com

STANDARD SPECIFICATION FOR LINING DUCTILE IRON PIPE FOR SEWER SERVICE

I. CONDITION OF DUCTILE IRON PRIOR TO SURFACE PREPARATION

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first six inches of the exterior of the spigot ends.

II. LINING MATERIAL

The Standard of Quality is Protecto 401™ Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

- A. A permeability rating of 0.00 when tested according to Method A of ASTM E-96 Procedure A with a test duration of 30 days.
- B. The following test must be run on coupons from factory lined ductile iron pipe:
 - ASTM B-117 Salt Spray (scribed panel) - Results to equal 0.0 undercutting after two years.
 - ASTM G-95 Cathodic Disbondment 1.5 volts @ 77° F. Results to equal no more than 0.5 mm undercutting after 30 days.
 - Immersion testing rated using ASTM D-714.
 - 20% Sulfuric acid—No effect after two years.
 - 140° F 25% Sodium Hydroxide—No effect after two years.
 - 160° F Distilled Water—No effect after two years.
 - 120° F Tap Water (scribed panel)—0.0 undercutting after two years with no effect.
 - ASTM G-22 Standard practice for determining resistance of Synthetic Polymeric materials to bacteria. The test should determine the resistance to growth of Acidithiobacillus Bacteria and should be conducted at 30 degrees centigrade for a period of 7 days on a minimum of 4 panels. The growth must be limited only to trace amounts of bacteria.
- C. An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: Section 7.8 Abrasion Resistance.

III. APPLICATION

Applicator

The lining shall be applied by a certified firm with a successful history of applying linings to the interior of ductile iron pipe and fittings. All applicators must be independently inspected at least two times per year to insure compliance with the requirements of this specification. This inspection must be coordinated and reviewed by the manufacturer of the lining material and any deviation from the application and/or quality requirements shall be corrected by the applicator. All inspections shall be in writing and a permanent record maintained.

Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance that can be removed by solvent, shall be solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide may be left on the surface. Any area where rust reappears before lining must be reblasted.

Lining

After surface preparation and within 12 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401™. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto 401™ Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To prevent delamination between coats, no material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.**

Touch-Up and Repair

Protecto 401™ Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

IV. INSPECTION AND CERTIFICATION

Inspection

- All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC PA-2 Film Thickness Rating.
- The interior lining of all pipe barrels and fittings shall be tested for pinholes with a non-destructive 2,500 volt test. Any defects found shall be repaired prior to shipment.
- Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.

V. HANDLING

Protecto 401™ lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying. The pipe shall not be dropped or unloaded by rolling.

Care should be taken not to let the pipe strike sharp objects while swinging or being off loaded. Ductile iron pipe should never be placed on grade by use of hydraulic pressure from an excavator bucket or by banging with heavy hammers.

SEALING CUT ENDS AND REPAIRING FIELD DAMAGED AREAS OF PROTECTO 401™ LINED PIPE AND FITTINGS.

1. Remove burrs caused by field cutting of ends or handling damage and smooth out the edge of the lining if rough.
2. Remove all traces of oil, grease, asphalt, dust, dirt, etc.
3. Remove any damaged lining caused by field cutting operations or handling and clean any exposed metal by sanding or scraping. Sandblasting or power tool cleaning roughening is also acceptable. It is recommended that any loose lining be removed by chiseling, cutting, or scraping into well-adhered lined area before patching. Be sure to overlap at least 1" of lining in the area to be repaired.
4. With the area to be sealed or repaired absolutely clean and suitably roughened, apply a coat of Protecto 401™ Joint Compound using the following procedure:
 - a) **Mixing Procedure**—The repair kit for Protecto 401™ contains two small cans of Protecto 401™ Touch-Up Material . Protecto 401™ Touch-Up is a two component epoxy and the contents of the small container shall be mixed with the contents of the large container. If less than the full contents of each can is to be mixed, the material may be mixed using the mixing ratio printed on the labels. After Part B is added to Part A, the mixture shall be thoroughly agitated. All activated material must be used within one hour of mixing.
 - b) **Application of Material**—After the material has been thoroughly mixed, it can be applied to the prepared surface by brush. Brushing is usually best due to the fact that the areas to be repaired are usually small. Practices conducive to a good coating are contained in the technical data sheet for Protecto 401™ Touch-Up.
5. It is important to coat the entire freshly cut exposed metal surface of the cut pipe end. To ensure proper sealing, overlap at least one inch of the lining with this repair material.

PROTECTO 401™ TOUCH-UP TECHNICAL DATA

DESCRIPTION: A brushable novalac epoxy designed for sealing cut ends and repairs when pipes are lined with Protecto 401™ Ceramic Epoxy.

LIMITATIONS: This material should be used on spigots and in bell sockets only after the pipe or fitting is lined with Protecto 401™ Ceramic Epoxy. Protecto 401™ Touch-Up can be used over Protecto 401™ or on bare substrate.

NOTE: *Do not apply Protecto 401™ over Protecto 401™ Touch-Up.*

SURFACE PREPARATION: The surface preparation shall be equal to the specifications for the project or as outlined in the touch-up procedure.

NOTE: *Do not apply Protecto 401™ Touch-Up over wet or frozen surfaces.*

DRY FILM THICKNESS: As outlined in specifications.

APPLICATION DATA:

APPLICATION: Brush, roll, or airless spray.

THINNING: Thin or clean up with Methyl Ethyl Ketone.

PHYSICAL DATA:

VOLATILE ORGANIC CONTENTS: <1.40 lbs. per gallon mixed unthinned.

SAFETY DATA: See individual product label for safety and health data information. Individual Material Safety data Sheets are available upon request.

**SIMULATED SEWER ENVIRONMENT ACCELERATED
 TESTING OF PROTECTO 401™ LINING IN
 PRODUCTION RUN DUCTILE IRON PIPE**

TEST	RESULTS
120° F Water Immersion	2.0 years No undercutting at scribe. No effect when rated using ASTM D-714
160° F Distilled Water Immersion	2.0 years No undercutting at scribe. No effect when rated using ASTM D-714
140° F 25% Sodium Hydroxide Immersion	2.0 years No effect when rated using ASTM D-714
20% Sulfuric Acid Immersion	2.0 years No effect when rated using ASTM D-714
ASTM B-117-19 Salt Spray 5% Salt @ 98° F	2.0 years No undercutting at scribe. No other effect when rated using ASTM D-714
EN 598 Section 7.8 (Modified) Abrasion Resistance	.002 inch (.05mm) loss After one million cycles (tested 2021)

Note: All Immersion tests are currently ongoing. Latest results per ASTM D-714-02R17, 2024

CHEMICAL RESISTANCE TESTING

Accidental Discharge of Strong Chemicals into Sewer Lines per NACE TM 0174-2022 Procedure B

TEST	PROTECTO 401™ Results 40 mil Nominal Thickness
1. Strong Acids	Pass - 50% Sulfuric, 30% Hydrochloric
2. Strong Base	Pass - 50% Sodium Hydroxide
3. Strong Solvents	Pass - Gasoline, 111 Trichlorethylene, Methyl Isobutyl Ketone, Propylene Glycol, Toluene, Hi-Sol 15
4. Strong Oxidizer	Pass - 50% Hydrogen Peroxide

ABRASION RESISTANCE PROTECTO 401™ LINING IN PRODUCTION LINED DUCTILE IRON PIPE

EN 598 Section 7.8

The abrasion resistance of Protecto 401 was tested in 2021 and measured using the European Standard EN 598: Ductile iron pipe, fittings, accessories and their joints for sewerage applications-section 7.8 Abrasion Resistance. The test and results are described as follows:

7.8 Abrasion Resistance

The test shall be carried out on a pipe sample 1,000 mm + 10 mm long, closed at both ends after enclosing the test material; preferred sizes are DN 200 and DN 400.

Before test, the pipe section shall be immersed in water at ambient temperature for approximately 24 hours.

The test material shall contain natural siliceous gravel to reach a level of 38 mm ± 2 mm above the invert with enough water to reach the same level. The gravel particle size shall be between 2 mm and 10 mm, with an average size of approximately 6 mm.

The pipe sample shall be fixed horizontally on a testing device capable of inclining the sample successively to an angle of plus 22,5° and minus 22,5° every 3 s to 5 s.

The pipe sample shall be examined after 100,000 cycles; the depth of abrasion shall be the average of 15 measurements taken every 50 mm along 700 mm of the pipe invert, excluding 150 mm at both ends.

The loss of lining thickness shall be no more than described in Section 5.7 Abrasion resistance:

Section 5.7 Abrasion Resistance

When tested in accordance with 7.8, the pipes shall not have an abrasion depth greater than 0.6 mm after 100,000 cycles.

ALLOWABLE LOSS ONE HUNDRED THOUSAND CYCLES	PROTECTO 401™ LOSS ONE MILLION CYCLES
.6 mm (23.6 mils)	.05 mm (2 mils)

DEFLECTION TESTING

PROTECTO 401™ CERAMIC EPOXY LINED DUCTILE IRON PIPE

Sample Preparation: The sample tested was a 4" wide ductile iron ring cut from factory lined ductile iron pipe.

LINING THICKNESS	TEST	RESULTS
.040 inches	Allows for 5% deflection without lining damage with a 2:1 safety factor.	No Effect

**FLOW CHARACTERISTICS OF PROTECTO 401™
CERAMIC EPOXY LINED DUCTILE IRON PIPE**

The inside diameter of ductile iron pipe averages 8.25% larger than the inside diameter of most other pipes. The calculations for flow should include the larger inside diameters of ductile iron pipe.

The Manning "n" and the Hazen-Williams "C Factor" for Protecto 401™ Ceramic Epoxy lined ductile iron pipe is equal to or better than cement mortar lined ductile pipe which is:

1. Manning "n" (open channel or partially-full sewers) = .011
2. C-Factor (full-flowing pressure pipe) = 140

The inside diameter of ductile iron pipe lined with the standard thickness (0.040 in. nominal) of Protecto 401™ Ceramic Epoxy is listed below:

Size (in.)	Outside* Diameter (in.)	Thickness Class 50 Inside* Diameter (in.)	Thickness Class 52 Inside* Diameter (in.)
6	6.90	6.32	6.20
8	9.05	8.43	8.31
10	11.10	10.44	10.32
12	13.20	12.50	12.38
14	15.30	14.56	14.44
16	17.40	16.64	16.52
18	19.50	18.72	18.60
20	21.60	20.80	20.68
24	25.80	24.96	24.84
30	32.00	31.14	30.98
36	38.30	37.36	37.16
42	44.50	43.48	43.24
48	50.80	49.70	49.42
54	57.56	56.34	56.02

***NOTE:** Tolerances per ANSI/AWWAC151/A21.51



GUARDIAN SYSTEMS, INC.

1108 Ashville Road
P.O. Box 190
Leeds, Alabama 35094

Telephone 205/699-6647
Wats 866/729-7211
Fax 205/699-3882

August 11, 2005

Mr. John Anspach
Induron Coatings, Inc.
P.O. Box 2371
Birmingham, Alabama 35201

Subject: Code of Federal Regulations

Dear Mr. Anspach,

Guardian Systems, Inc. performed a Water Extractability Test on Protecto 401 Ceramic Epoxy coating provided by Induron Coatings, Inc. The coating was applied to glass plates and cured for one week. The test was run per exposure conditions 4(v) simulating room temperature filling and storage. The plates were placed in D.I. water for twenty-four hours at 120°F. The water was evaporated and the residue weighed to the nearest 0.1 milligram.

The calculated result of 7.0mg/L was less than 50mg/L (ppm), which is the reference point for doing extended analysis to determine chloroform-soluble extractives. The water extractable results of 0.30mg/sqin is well below the reference of 18mg/in² for a coating intended for repeat use.

Attached are copies of the Code of Federal Regulations Volume 21 Part 175.300 to use as reference material.

If you have further questions, please contact me at (205) 699-6647.

Sincerely,



Jerry Horncastle
Laboratory Manager

characterizing the type of food, and under conditions of time and temperature characterizing the conditions of its intended use as determined from tables 1 and 2 of paragraph (d) of this section, shall yield chloroform-soluble extractives, corrected for zinc extractives as zinc oleate, not to exceed the following:

(1) From a coating intended for or employed as a component of a container not to exceed 1 gallon and intended for one-time use, not to exceed 0.5 milligram per square inch nor to exceed that amount as milligrams per square inch that would equal 0.005 percent of the water capacity of the container, in milligrams, divided by the area of the food-contact surface of the container in square inches. From a fabricated container conforming with the description in this paragraph (c)(1), the extractives shall not exceed 0.5 milligram per square inch of food-contact surface nor exceed 50 parts per million of the water capacity of the container as determined by the methods provided in paragraph (e) of this section.

(2) From a coating intended for or employed as a component of a container having a capacity in excess of 1 gallon and intended for one-time use, not to exceed 1.8 milligrams per square inch nor to exceed that amount as milligrams per square inch that would equal 0.005 percent of the water capacity of the container in milligrams, divided by the area of the food-contact surface of the container in square inches.

(3) From a coating intended for or employed as a component of a container for repeated use, not to exceed 18 milligrams per square inch nor to exceed that amount as milligrams per square inch that would equal 0.005 percent of the water capacity of the container in milligrams, divided by the area of the food-contact surface of the container in square inches.

* (4) From coating intended for repeated use, and employed other than as a component of a container, not to exceed 18 milligrams per square inch of coated surface.

(d) Tables:

Table 1 Types of Food

- I. Nonacid (pH above 5.0), aqueous products; may contain salt or sugar or both, and including oil-in-water emulsions of low- or high-fat content.
- II. Acidic (pH 5.0 or below), aqueous products; may contain salt or sugar or both, and including oil-in-water emulsions of low- or high-fat content.
- III. Aqueous, acid or nonacid products containing free oil or fat; may contain salt, and including water-in-oil emulsions of low- or high-fat content.
- IV. Dairy products and modifications:
 - A. Water-in-oil emulsion, high- or low-fat.
 - B. Oil-in-water emulsion, high- or low-fat.
- V. Low moisture fats and oils.
- VI. Beverages:
 - A. Containing alcohol.
 - B. Nonalcoholic.
- VII. Bakery products.
- VIII. Dry solids (no end test required).

**GASKETED MECHANICAL JOINT VACUUM PROOF TEST
ASTM F1476-95a**



Professional Service Industries, Inc.
ORDER NO: 47048035
DATE: March 6, 2000


On March 6, 2000, a 30" diameter by 4' long, plain end by plain end ductile iron pipe, lined with Protecto 401™ Ceramic Epoxy, was subjected to a vacuum proof test. The test conducted was in accordance to the Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Application, ASTM F 1476-95a, a Class 3 design, gasketed mechanical coupling, i.e., a flexible and unrestrained coupling.

For the vacuum test, each end of the 30" pipe was capped off with a TYTON® Joint Cap Fitting. After connecting the test assembly to the vacuum pump, the pump was turned on, a vacuum of 25 inches of mercury was drawn, and the assembly was sealed with a 3/4" DynaQuip® ball valve.

The vacuum was held for an uninterrupted time period of 7 minutes without loss of vacuum. The vacuum gage used for measurement during this test was a Model No. 1980, Ametek gage with a range of 0-30" Hg, graduated in 1/10th inches of mercury. The gage was certified to be in conformance with the requirements of ASTM F 1476, i.e., +/- 1% or better throughout the gage's range.

After the vacuum test, the pipe was uncapped and the lining was examined. No disbondment or damage to the lining was detected.

This test was performed in the presence of a representative of Professional Service Industries. We certify that the results of this test are correct and accurately reported herein as observed by our representative.

PROFESSIONAL SERVICE INDUSTRIES, INC.

Wesley Rarkhurst Jr.



THE PROVEN CERAMIC EPOXY LINING
888-SPEC-401 | PROTECTO401.COM

THIRD PARTY TESTING

GEORGE MILLS & ASSOCIATES INTERNATIONAL, INC.

HOUSTON

P.O. Box 847 | Humbler, TX 77347
Tel: (713) 852-7600 | Fax: (713) 852-8777

NASHVILLE

3133 Knobview Drive
Nashville, TN 37214
Tel: (615) 391-4785 | Fax: (615) 885-9655

TEST METHOD: ASTM G-95:

Standard Test Method for Resistance to Cathodic Disbondment by the Attached Cell Method.

COATING SYSTEM:

Protecto 401™ CERAMIC EPOXY Lining: Plant applied Protecto 401™ Ceramic Epoxy lined ductile iron pipe (DIP) cut into 6 inch x 6 inch coupons.

PROCEDURE:

Following ASTM G-95, a five inch tall by four inch diameter section of PVC pipe, ground to the approximate curvature of the internal surface of the pipe coupon, was attached via RTC silicone caulk. A 0.25 inch holiday was drilled through the coating to metal in the center of each coupon. A 0.25 inch hole was drilled through one corner of each coupon and fitted with a bolt to provide attachment of the negative lead from the impressed current cathodic protection power supply. Triplicate coupons were subjected to simulated cathodic protection by impressing a 1.5 volt potential between the metal and an electrode within the CD cell for a period of thirty days. The electrolyte used was 3% sodium chloride in tap water.

An additional set of coupons were subjected to the same test regime with the exception that they were maintained at 60°C on a sand bath. The hot (60°C) cells were covered with plastic wrap to minimize evaporative losses. Evolved hydrogen was able to escape through the plastic and did not present a problem.

The values given are in mm of disbondment increase in diameter from original RADIUS of holiday.

PANEL NUMBER	INCREASE IN RADIUS
154 (Room Temp.)	0 mm
157 (Room Temp.)	0 mm
156 (Room Temp.)	0.5 mm

PANEL NUMBER	INCREASE IN RADIUS
*155 hot (60°C)	xx
* 158 hot (60°C)	xx
159 hot (60°C)	2 mm

* Over heated; suffered thermal damage after leaking dry over week end.

CERTIFIED:

Dr. George Mills



GEORGE MILLS & ASSOCIATES INTERNATIONAL, INC.

HOUSTON

P.O. Box 847 | Humble, TX 77347
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NASHVILLE

3133 Knobview Drive
Nashville, TN 37214
Tel: (615) 391-4785 | Fax: (615) 885-9655**TEST METHOD: ASTM 117:**

Standard Test Method of Salt Spray (Fog) Testing.

COATING SYSTEM:

PROTECTO 401™ CERAMIC EPOXY Lining: Plant applied epoxy lined ductile iron pipe (DIP) cut into 4 inch x 6 inch coupons.

PROCEDURE:

Using the ASTM B 117 salt fog apparatus and procedures with the exception that the film was not scribed so as to allow observation of underfilm corrosion creep along cut edges of coupon. Duration of the test was 1080 hours (45 days).

PANEL NUMBER	AVERAGE MM COROSION UNDERCUT ABOUT PERIPHERY OF COUPON
147	0 mm
148	0 mm
149	0 mm

There was no corrosion undercutting of the coating although heavy corrosion product developed along the unprotected edges. Coating could not be forced to delaminate by vigorous probing.

CERTIFIED:



Dr. George Mills



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THIRD PARTY TESTING

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3133 Knobview Drive
Nashville, TN 37214
Tel: (615) 391-4785 | Fax: (615) 885-9655

DATE: March 14, 1994

TEST METHOD: ASTM D-1308:

Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Finishes. (Chemical Soak Test with Nine Test Solutions)

COATING SYSTEM:

PROTECTO 401™ CERAMIC EPOXY Lining: Plant applied Protecto 401™ lined ductile iron pipe (DIP) cut into 3 inch x 4 inch coupons.

TEST DURATION and CONDITIONS:

1080 hours (45 days), Room temperature, panels submerged 50% to provide liquid and vapor phase testing.

Coupons, cut from plant applied Protecto 401™ Ceramic Epoxy lined pipe, were subjected to specific 1080 hour (45 day), 70°C partial submersion in a series of strong chemicals. The test solutions and results are tabulated below.

CHEMICAL SYSTEM	RESULTS
3% Sulfuric Acid	Pass: Coating unaffected; Corrosion to opposite side of metal coupon.
10% Sulfuric Acid	Pass: Coating unaffected; Corrosion to opposite side of metal coupon.
5% Sodium Hydroxide	Pass: Coating unaffected.
20% Sodium Hydroxide	Pass: Coating unaffected.
25% Sodium Hydroxide	Pass: Coating unaffected.
10% Hydrochloric Acid	Pass: Coating unaffected; Heavy corrosion loss to opposite side of coupon.
Gasoline	Pass: Coating unaffected; Some discoloration of gasoline.
Toluene	Pass: Coating unaffected; Some discoloration of toluene.
DI Water	Pass: Coating unaffected.
Hot Water (45 day @ 76°C)	Pass: Coating unaffected.

CERTIFIED:

Dr. George Mills
Date: 12 July 1994



PROTECTO 401™'S ABILITY TO PROTECT DUCTILE IRON FROM ACID ATTACK

Induron has included independent test data concerning the growth of Acidithiobacillus Bacteria on the Protecto 401™ Ceramic Epoxy lining of ductile iron pipe and fittings. The growth of this bacteria contributes to the erosion of ferrous metals and concrete in sewer service, since this bacteria produces sulfuric acid as a waste product when it consumes hydrogen sulfide.

It is our opinion, based upon ASTM G 22 90 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria, that Protecto 401™ Ceramic Epoxy is not only an excellent barrier coat with zero permeability and resistance to high percentages of both bases and acids, but also a non-ablative (non-sacrificing) bactericide—which dramatically reduces the growth of thiobacillus bacteria, the main culprit in damage to sewer lines.

Because Protecto 401™ Ceramic Epoxy is constructed to produce a lining that has a higher pH throughout the lining and acidithiobacillus have to have an acid environment to flourish then Protecto 401™ Ceramic Epoxy acts as a bactericide without any loss of film integrity. The proof is in the testing. (see attached) The bare metal grows acidithiobacillus, when subjected to the warm moist climate and inoculated with the bacteria, at an alarming rate.

Protecto 401™ Ceramic Epoxy (which is referred to as the Black Epoxy Coupons in the test data), limits growth to only traces.

This added advantage—plus the unique construction of Protecto 401™ Ceramic Epoxy—is the reason for the longevity of Protecto 401™ Ceramic Epoxy in sewer service on ductile iron pipe and fittings.

Microbe Inotech Laboratories, Inc.
Summary Report of Analysis
[MILB -5554A]

John Anspach
 Induron Coatings
 3333 Richard Arrington, Jr. Blvd North
 Birmingham, AL 35234
 Phone: 205-321-9626
 Fax: 205-324-6942

July 3, 2008

Description and Chain of Custody Record Information:

- Thursday, May 29, 2008 - 4:20PM: Received by Fed Ex, four (4) types of metal coupons (20 Black epoxy coupons, 20 Red epoxy coupons, 20 Tan epoxy coupons, and 20 blank coupons, total of 80 coupons) for a biodegradability study using *Acidithiobacillus ferrooxidans*.
- MILB Report & Invoice Number: 5554A (down payment) and 5554B (remaining balance).
- Proposal Option #3

Sample Processing:

- ASTM G22 96 Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Bacteria.
- **Test Setup:** A metal coupon was placed on top of sterile water agar. The coupon was then inoculated with 1 mL of *Acidithiobacillus ferrooxidans* in growth media. This process was repeated 12 times for each coupon type. The replicates were then placed at 30°C for growth.
- **Controls:** Four (4) coupons were placed on sterile water agar and were not inoculated. These replicates were placed at 30°C. Four (4) additional squares of ribbon were placed on sterile water agar and were inoculated with sterile *Acidithiobacillus ferrooxidans* media. These replicates were placed at 30°C.
- **Observations for Growth:** Observations for growth were made at 7 days from inoculation. The following ratings were used for the observations:


Observed Growth on Specimens	Rating
None	0
Traces of growth (less than 10%)	1
Light growth (10-30%)	2
Medium growth (30-60%)	3
Heavy growth (60%-complete coverage)	4


Results

Data: Aerobic Growth Results		
	Replicate	7 Day
Coupon coated in Black Epoxy	1	1
	2	1
	3	1
	4	1
	5	1
	6	1
	7	1
	8	1
	9	1
	10	1
	11	1
	12	1
Average Aerobic		1
Media Control	1	0
	2	0
	3	0
	4	0
Average Media Control		0
Negative Control	1	0
	2	0
	3	0
	4	0
Average Negative Control		0

Data: Aerobic Growth Results		
	Replicate	7 Day
Coupon without epoxy coat	1	4
	2	4
	3	4
	4	4
	5	4
	6	4
	7	4
	8	4
	9	4
	10	4
	11	4
	12	4
	13	4
	14	4
	15	4
	16	4
Average Aerobic		4
Media Control	1	3
	2	2
Average Media Control		2.5
Negative Control	1	0
	2	0
Average Negative Control		0

Thank you from the staff on project:


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Laboratory Manager


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PERMEANCE ASTM E-96

COATINGS RESEARCH GROUP, INC.

2340 Hamilton Avenue, Cleveland, Ohio 44114 U.S.A.
216-781-9122 *** FAX 216-781-9239

DATE: March 10,1993

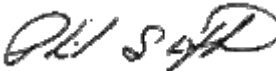
TO: Bill Setser
FROM: Phil Slifko
SUBJECT: Perm Rating of Indurall Sample PROTECTO 401™

Procedure A of ASTM 96-66, described in Project 10-002 p 14-30 (February 1979), was used to determine the permeance of the submitted paint sample. Over a period of thirty days in our humidity cabinet, relative humidity (outside the cup) and temperature averaged 48.6% and 78.0° F (25.6°C), respectively. Glidden's Insul-aid was used as the control in this test. The permeance of the Protecto 401™ (Q8-2401 [component A] blended with D8- 2401 [component B]) along with the control are shown in the following Table:

TABLE: Perm Rating of Test Coatings

COATING	PROTECTO 401™	GLIDDEN INSUL-AID
DRY FILM THICKNESS (MILS)	53.00	2.36
PERMS	0.00	0.63

*All samples were run in duplicate and averaged for permeance.

Sincerely,

Phil Slifko

**LONG-TERM ABOVE GROUND STORAGE
OF PROTECTO 401™ CERAMIC EPOXY LINED
DUCTILE IRON PIPE AND FITTINGS**

Protecto 401™ Ceramic Epoxy is designed to perform in sewer service. Extended above ground storage requires some precautions. Although our experience indicates that the majority of Protecto 401™ Ceramic Epoxy lined pipe and fittings do not have problems with years of above ground storage, the probability of damage from repeated handling (moved from one job to the next) and damage from high temperatures in extreme climates, escalates with long term above ground storage. Protecto 401™ lined ductile iron pipe and fittings must be put in sewer service in good condition in order to perform up to Protecto 401™ Ceramic Epoxy's decades-long quality standard.

Based upon testing and experience in long term above ground storage, it is Induron's opinion that Protecto 401™ Ceramic Epoxy lined ductile iron pipe and fittings stored with exposure to the heat of the sun should be installed within one year of lining. The date of lining is in the set of numbers written on the interior of the pipe or fitting.

However, depending upon ambient conditions, location of storage, and other factors, installation times up to 18 months from the time of lining may be approved if requested in writing and accompanied by inspection within two weeks prior to burial by an approved Protecto 401™ applicator, a representative of the pipe manufacturer, or an authorized Induron representative. Additionally, lined pipes and fittings may be stored for longer periods if they are kept at an Induron-certified storage facility.

If installation within one year is not anticipated, then Induron recommends measures which may be taken for the protection of the Protecto 401™ Ceramic Epoxy lined pipe and fittings for extended storage above ground. The precautions for long-term storage are intended to protect the pipe and/or fittings, which are painted black, from the extreme heat generated in harsh climates due to extended exposure to sunlight. This may be accomplished by moving them under cover or covering all exposed sunlit black surfaces with white latex paint or well-ventilated, light-colored tarps (or shed roof). All Protecto 401™ Ceramic Epoxy lined pipe or fittings should undergo a thorough visual inspection by the installer to determine that no damage is present prior to installation.

These recommendations are designed to ensure that Protecto 401™ Ceramic Epoxy lined ductile iron pipe and fittings are treated as quality products and that proper rotation of stock is a priority. This document supersedes all other documents pertaining to this subject.