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## 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-96-66, 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-714-87.
    - 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 90 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: 1994 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.

#### 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 8 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.

## **ESPECIFICACIÓN ESTÁNDAR PARA EL REVESTIMIENTO DE TUBERÍA DE HIERRO DÚCTIL PARA SERVICIOS DE DRENAJE**

### **I. Condición del Hierro Dúctil Antes de la Preparación de la Superficie**

Toda la tubería y las conexiones se entregarán al lugar donde se lleve a cabo la aplicación sin asfalto, revestimiento de cemento, o cualquier otro revestimiento en la superficie interior. Dado que la eliminación de los revestimientos previos podría no ser posible, la intención de este estándar es que el interior de toda la tubería y las conexiones de hierro dúctil no hayan sido recubiertos con alguna sustancia antes de la aplicación del material especificado para revestimiento, y ningún recubrimiento haya sido aplicado a las primeras seis pulgadas del exterior de la tubería.

### **II. Material de Revestimiento**

El Estándar de Calidad es Protecto 401™ Ceramic Epoxy (Compuesto adhesivo Cerámico). El material será un compuesto epóxico Novalac curado con una amina conteniendo por lo menos 20 por ciento por volumen de pigmento de cuarzo de cerámica. Cualquier solicitud para su sustitución debe estar acompañada por un historial que demuestre ser exitoso en el revestimiento de tubería y conexiones para el servicio de drenaje, un informe de pruebas verificando las propiedades enunciadas a continuación, y una certificación de los resultados de las pruebas.

- A. Una clasificación de permeabilidad de 0.00 cuando habiendo sido probado de acuerdo al Método A de la ASTM E-96-66. Procedimiento A con una duración de prueba de 30 días.
- B. La siguiente prueba debe ser hecha en cupones de tubería de hierro dúctil revestido en fábrica:
  - 1. ASTM B-117 Salt Spray – prueba de corrosión con aerosol de sal (panel grabado) - Resultados de 0.0 de erosión después de dos años.
  - 2. ASTM G-95 Desprendimiento Catódico a 1.5 voltios en 77° F. Resultados de no más de 0.5 milímetros de desprendimiento después de 30 días.
  - 3. Prueba de inmersión usando ASTM D-714-87.
    - a. 20 por ciento Ácido Sulfúrico—Ningún efecto después de 2 años.
    - b. 140°F 25 por ciento Hidróxido de Sodio—Ningún efecto después de 2 años.
    - c. 160°F Agua Destilada—Ningún efecto después de 2 años.
    - d. 120°F Agua de la Llave (panel grabado)—0.0 de erosión después de 2 años con ningún efecto.
- C. Una resistencia a la abrasión que muestre una pérdida de no más de 3 milésimas de pulgada (.075 milímetros) después de un millón de ciclos usando el Estándar Europeo EN 598: 1994 Sección 7.8 Resistencia a la Abrasión.

### **III. Aplicación**

- A. Aplicador  
El revestimiento se aplicará por una empresa certificada con un historial exitoso de aplicación de recubrimientos en el interior de tubería y conexiones de hierro dúctil.
- B. Preparación de la Superficie  
Antes de la limpieza por granallado o sandblast, toda el área que va a recibir el compuesto Protecto 401™ se inspeccionará por si hay presencia de aceite, grasa, etc. Cualquiera área con grasa, aceite, o cualquier sustancia que pueda ser removida por algún solvente, debe ser limpiada con solvente para remover esas sustancias. Después de que la superficie esté libre de grasa, aceite u otras sustancias, toda el área que va a recibir los compuestos Protecto 401™ es deben ser limpiados abrasivamente usando arena o granalla metálica. Toda la superficie a la que se le va a aplicar el recubrimiento se limpiará con un equipo de sandblast o granallado para que toda la oxidación, los

óxidos sueltos, etc., sean quitados de la superficie. Solamente manchas pequeñas y óxido pegado firmemente se puede dejar en la superficie. Cualquier superficie donde reaparezca la oxidación antes del revestimiento debe ser granallada otra vez.

C. Revestimiento

Después de preparar la superficie y dentro de las 8 horas después de preparar la superficie, el interior del tubo recibirá un espesor nominal de 40 milésimas de pulgadas de capa seca de Protecto 401™. No se debe aplicar cuando la temperatura del sustrato ni del ambiente esté a menos de 40°F (4.5 °C). La superficie también debe estar seca y sin polvo. Si tubería con extremos bridados o conexiones bridadas están incluidos en el proyecto, el revestimiento no se utilizará en la cara de las bridas.

D. Recubrimiento de las cavidades del empaque y del extremo del tubo  
Debido a las tolerancias involucradas, el área del empaque y el extremo del tubo hasta 6 pulgadas atrás del final del extremo del tubo debe recibir una capa nominal de 6 milésimas de pulgadas a 10 milésimas máximo, usando Protecto 401™ Joint Compound (Compuesto de adhesión de juntas Protecto 401™). El Compuesto de adhesión de juntas se aplicará con una brocha para asegurar que todo esté cubierto. Esto debe ser hecho con cuidado para que el Compuesto de adhesión de juntas esté suave sin aumento en exceso en el asiento del empaque o en los extremos del tubo. La capa Protecto 401™ a que se aplicará al asiento del empaque y a los extremos del tubo deberá ponerse después de aplicar el revestimiento.

E. Número de Capas

El número de capas del material de revestimiento será el recomendado por el fabricante del mismo. Sin embargo, en ningún caso debe aplicarse este material por encima del espesor seco por capa recomendada por el fabricante en su publicación de especificaciones técnicas. El tiempo máximo o mínimo entre capas será ese tiempo recomendado por el fabricante del material del revestimiento. **Para prevenir la delaminación entre capas, ningún material deberá ser usado para revestimiento el cual no pueda ser recubierto sobre si mismo indefinidamente sin que la superficie se vuelva áspera.**

F. Retocar y Reparar

Protecto 401™ Joint Compound (Compuesto de adhesión de juntas- Protecto 401™) debe ser usado para retocar o reparar de acuerdo con las recomendaciones del fabricante.

#### IV. Inspección y Certificación

A. Inspección

1. El espesor de los revestimientos de toda tubería y conexiones de hierro dúctil serán verificados con un indicador magnético de espesor. La prueba de espesor será hecha usando el método delineado en SSPC PA -2 Film Thickness Rating (Clasificación de Espesor de Capa).
2. El revestimiento interior de todos los tubos y conexiones deberá ser verificado para detectar porosidades con una prueba no destructiva de 2,500 voltios. Cualquier defecto que se encuentre debe ser reparado antes de envío.
3. Cada tubo y conexión deberá ser marcado con la fecha de aplicación del revestimiento junto con una secuencia numérica de las aplicaciones hechas en esa fecha y los registros del trabajo deberán ser mantenidos por el aplicador.

C. Certificación

El fabricante del tubo o de la conexión deberá suministrar un certificado atestiguando el hecho de que el aplicador cumplió con los requisitos de esta especificación, y que el material usado fue el especificado.

#### V. Manejo

El tubo y las conexiones recubiertas con Protecto 401™ deben ser manipuladas solamente por el exterior. Ninguna horquilla, cadena, correa, gancho, etc., se colocará dentro del tubo o las conexiones para levantar, posicionar, o colocar.



Section V—Reactivity Data 38			
Stability	Unstable		Conditions to Avoid
	Stable	X	
Incompatibility (Materials to Avoid)			
Hazardous Decomposition or Byproducts			
Above 450°F - CO, CO2, Hydrocarbons, Benzene			
Hazardous Polymerization	May Occur		Conditions to Avoid
	Will Not Occur	X	
Open Flame			
Section VI—Health Hazard Data			
Route(s) of Entry	Inhalation?	Skin?	Ingestion?
	YES	YES	N/A
Health Hazards (Acute and Chronic)			
Avoid long-term skin contact; use fresh air device if entering confined space.			
Cardinogenicity	NTP?	IARC Monographs?	OSHA Regulated?
N/A	N/A	N/A	No
Signs and Symptoms of Exposure			
Skin sensitivity or rash on long-term exposure; headache, nausea and/or dizziness if breathed in confined space.			
Medical Conditions			
Generally Aggravated by Exposure			
Allergies, respiratory diseases.			
Emergency and First Aid Procedures			
Provide fresh air, wash skin and see a doctor.			
Section VII—Precautions for Safe Handling and Use			
Steps to Be Taken in Case Material is Released or Spilled			
N/A			
Waste Disposal Method			
Sanitary landfill – obtain prior approval for large quantities.			
Precautions to Be Taken in Handling and Storing			
Normal protective clothing used in handling construction materials.			
Other Precautions			
None			
Section VII—Control Measures			
Respiratory Protection (Specify Type)			
Ventilation	Local Exhaust	N/A	Special
	Mechanical (General)	N/A	
			Use fresh air device if entering pipe in confined space.
			Other
			N/A
Protective Gloves		Eye Protection	
Recommended to avoid cuts/physical injury.		Safety glasses recommended when cutting	
Other Protective Clothing or Equipment			
None			
Work/Hygienic Practices			
Avoid prolonged skin contact; wear NIOSH/MSHA TC-21C-132 type dust/mist respirator when sanding, grinding, blasting or cutting the dry film of this material.			

### PHOTO EXAMPLES



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

There have been many questions concerning the above ground storage of Protecto 401™ Ceramic Epoxy lined ductile iron pipe and fittings. Protecto 401™ Ceramic Epoxy was 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 as good condition as possible in order to perform up to Protecto 401™ Ceramic Epoxy's 29 year service record of no in-service failure.

Based upon testing and some limited experience in long term above ground storage, it is Induron's opinion that Protecto 401™ Ceramic Epoxy lined ductile iron pipe and fittings should be installed within one year of lining. The date of lining is the first set of numbers in white 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 authorized Induron representative, an approved Protecto 401™ applicator, or a representative of the pipe manufacturer.

If installation within one year of lining is not accomplished, 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. All Protecto 401™ Ceramic Epoxy lined pipe or fittings, whether stored above ground past one year or not, should undergo a thorough visual inspection by the installer to determine that no damage is present prior to installation.

The one year from lining requirement is 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. .

December 4, 2008

## **GUIDELINES FOR PRESSURE CLEANING THE INTERNAL DIAMETER OF DUCTILE IRON PIPE**

The Ductile Iron Pipe Research Association (and its Member Companies), Federal Signal Corporation (and its subsidiaries Vactor, Elgin, Guzzler, Jetstream & Ravo), and Induron Coatings Inc. participated in a pressure cleaning research program which was conducted by the Missouri University of Science and Technology – High Pressure Waterjet Laboratory.

The test program included asphaltic seal coated cement-mortar lined and Protecto 401™ lined ductile iron pipe which resulted in guidelines for the pressure cleaning of the inside diameters of ductile iron pipe. Through a collaborative effort with the organizations above and the City of Moline, Illinois, field tests were conducted and the guidelines verified as effective and safe for cement-mortar and Protecto 401™ lined ductile iron pipe.

### **GUIDELINES ARE AS FOLLOWS:**

1. The nozzle shall be configured with fan jets only (no round jets).
2. The fan jets should be oriented at a maximum angle of 30 degrees to the pipe wall.
3. The nozzle shall be a minimum of 2-inches standoff from the pipe surface.
4. The nozzle assembly shall be self-rotating and incorporate a rotational control mechanism - target speed of 30 rpm.
5. The water pressure at the nozzles shall be no more than 1,800 psi.
6. The nozzle assembly shall have non-abrasive wheels and/or UHMW (ultra-high molecular weight) polyethylene skids positioned so that at no time does the nozzle assembly contact the lining of the pipe.
7. The nozzle assembly shall continually move when pressure washing with no hesitation in the pipe.
8. All hose couplings, hoses, etc. shall be smooth so as to facilitate movement across the pipe joints without creating damage to the lining.

Pipe diameters of 24-inch and larger may require additional passes for effective cleaning.



### **VACTOR BLUE TWISTER NOZZLE (OR EQUAL) AND APPROPRIATE ASSEMBLY**

Although research shows no significant damage in testing, the decision to pressure wash, if made by the customer, engineer, or installer, may present some risk of damage to the Protecto 401™ lining.

Any such risk is dependent on water pressure, speed, jet design and angle to the lining, distance of the jet from the lining, type of lining, and other factors. Induron does not warrant or guarantee the result or assume any risk associated with pressure washing.

## **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.

## **PROCEDIMIENTO PARA SELLAR TERMINACIONES Y REPARAR AREAS DE CAMPO DAÑADAS DE TUBERIA Y ACCESORIOS REVESTIDOS CON PROTECTO 401™**

1. Remueva las rebabas causadas por los cortes de terminaciones o daños de manejo y suavice los bordes del revestimiento si están ásperos.
2. Remueva todo residuo de aceite, grasa, asfalto, polvo, sucio, etc.
3. Remueva cualquier revestimiento dañado a causa de operaciones de corte o manejo y limpie cualquier metal expuesto mediante lija o espátula. El uso de lijadora o herramienta eléctrica para limpiar y endurecer también es aceptable. Se recomienda que cualquier revestimiento suelto sea removido mediante cincel, corte o espátula hasta que el revestimiento quede bien adherido, antes de sellar. Asegúrese de poner al menos una pulgada de doble revestimiento en el área que será reparada.
4. Con el área que será sellada y reparada absolutamente limpia y adecuadamente endurecida, aplique una capa de "Protecto 401™ Joint Compound" mediante el siguiente procedimiento:
  - a) Procedimiento para mezclar – el equipo de reparación para "Protecto 401" contiene dos latas pequeñas de "Protecto 401™ Touch-Up Material". "Protecto 401™ Touch-Up" es un epóxico de dos componentes y el contenido del envase pequeño debe ser mezclado con el contenido del envase grande. Si la cantidad a mezclarse es menor que el contenido completo de cada lata, el material puede ser mezclado utilizando la proporción impresa en las etiquetas. Después de que la Parte B sea mezclada con la Parte A, la mezcla debe agitarse fuertemente. Todo el material activado debe ser usado antes de que transcurra una hora a partir del momento en que fue mezclado.
  - b) Aplicación del material – Después de que el material haya sido bien mezclado, puede ser aplicado mediante brocha a la superficie preparada. La brocha usualmente funciona mejor debido a que las áreas a ser reparadas son usualmente pequeñas. Las formas para obtener buenas capas están incluidas en la hoja de datos técnicos para "Protecto 401™ Touch-Up".
5. Es importante cubrir en su totalidad la recién cortada superficie metálica de la terminación cortada. Para asegurar una proporción adecuada, ponga al menos una pulgada de doble revestimiento con este material de reparación.

### **DATOS TECNICOS DEL "PROTECTO 401™ TOUCH-UP"**

**DESCRIPCION:** Es un epóxico resinoso ("novalac") aplicable con brocha, diseñado para poner en proporción las terminaciones, y que repara cuando las tuberías están revestidas con "Protecto 401™ Ceramic Epoxy".

**LIMITACIONES:** Este material debe ser utilizado en grifos y en enchufes de campana sólo después de que la tubería o el accesorio sea revestido con "Protecto 401™ Ceramic Epoxy". El "Protecto 401™ Touch-Up" puede ser usado sobre el "Protecto 401" o en sustrato descubierto. **Nota: No aplique "Protecto 401" sobre "Protecto 401™ Touch-Up".**

**PREPARACION DE LA SUPERFICIE:** La preparación de la superficie debe llevarse a cabo de acuerdo a las especificaciones del proyecto o según bosquejada en el procedimiento de retoque. **No aplique "Protecto 401™ Touch-Up" sobre superficies mojadas o congeladas.**

**GROSOR DE LA CAPA SECA:** Como bosquejado en las especificaciones.

**DATOS PARA APLICACION:** Brocha, rolo o aerosol sin aire.

**ADELGAZAMIENTO:** Adelgace o limpie con "Methyl Ethyl Ketone"

### **DATOS FISICOS:**

**CONTENIDO ORGANICO VOLATIL:** menor que 1.40 libras por galón mezclado no adelgazado.

**DATOS DE SEGURIDAD:** Vea la etiqueta individual del producto para información acerca de seguridad y salud. Las Hojas de Datos de Seguridad de Material Individual están disponibles si son solicitadas.

## **MAXIMUM OPERATING TEMPERATURE**

Protecto 401™ Ceramic Epoxy Lined Ductile Iron Pipe

The maximum continuous operating temperature for Protecto 401™ Ceramic Epoxy lined ductile iron pipe is 120°F immersion. Surges up to 150°F may be allowed if the 150°F is not the norm but is infrequent.

**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-714-87
160°F Distilled Water Immersion	2.0 years No undercutting at scribe. No effect when rated using ASTM D-714-87
140°F 25% Sodium Hydroxide Immersion	2.0 years No effect when rated using ASTM D-714-87
20% Sulfuric Acid Immersion	2.0 years No effect when rated using ASTM D-714-87
ASTM B-117-85 Salt Spray 5% Salt @ 98°F	2.0 years No undercutting at scribe. No other effect when rated using ASTM D-714-87
EN 598-1994 Section 7.8 Abrasion Resistance	.002 inch (.05mm) loss After one million cycles

Note: All Immersion tests are currently ongoing.

## **CHEMICAL RESISTANCE TESTING**

### **Accidental Discharge of Strong Chemicals into Sewer Lines**

<b>TEST</b>	<b>PROTECTO 401™ Results 40 mil Nominal Thickness</b>
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 and measured using the European Standard [EN 598](#): 1994-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:

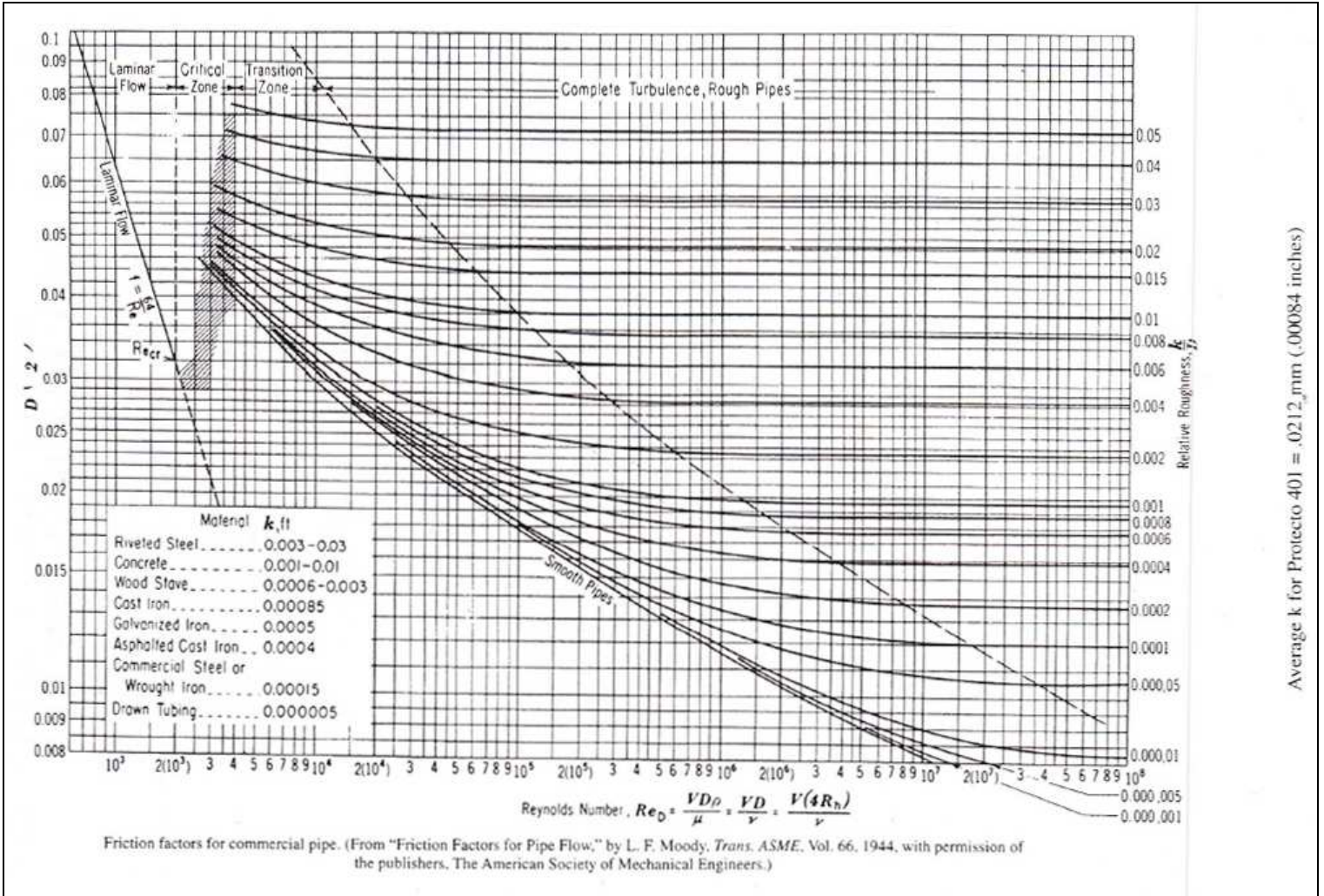
1. Manning "n" (open channel or partially-full sewers) = .011
2. C-Factor (full-flowing pressure pipe) = 140

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

### FLOW CHART



**PROTECTO 401™ VS. POLYAMIDE COAL TAR EPOXY**

TEST	PROTECTO 401	POLYAMIDE COALTAR EPOXY
PERMEABILITY Procedure "A" of ASTM E-96-6642 Day Test Duration	0.00 perms	.22 perms
<b>NOTE:</b> The lower the permeability rating, the less water borne chemicals can penetrate the lining.		
<b>IMMERSION</b> in 20% sulfuric acid	No blisters or delamination of lining after <b>24 months</b> .	Blisters over all of the tested area of lining after <b>3 months</b> . Test terminated.
<b>SALT SPRAY</b> 5% solution ASTM B 117-85 Scribed	<b>24 months</b> No undercutting at scribe. No damage to panel.	After <b>4.7 months</b> no undercutting at scribe. No damage to panel
<b>NOTE:</b> All materials were tested with an average film thickness of 40 mils.		

**PROTECTO 401™ VS. POLYETHYLENE**

TEST	PROTECTO 401	POLYETHYLENE
<b>160° F DISTILLED WATER IMMERSION</b> scribed panels Rated using ASTM D-714-87	<b>24 months</b> slight red rust in scribe, no undercutting.	<b>1-1/2 months</b> delamination of film, test terminated.
<b>120° F TAP WATER IMMERSION</b> scribed panels Rated Using ASTM D-714-87	<b>24 months</b> slight red rust in scribe, no undercutting.	<b>6 months</b> film curls back 1/2" from scribe, test terminated.
<b>140° F 25% SODIUM HYDROXIDE IMMERSION</b> Rated Using ASTM D-714-87	<b>24 months</b> no effect.	<b>1-1/2 months</b> delamination of film, test terminated. unscribed
<b>SALT SPRAY</b> ASTM B-117 scribed panels	<b>24 months</b> red rust in scribe, no undercutting.	<b>1-1/2 months</b> 1-1/2" under-cutting at scribe. Test terminated
Note: All materials were tested with an average film thickness of 40 mils on production-run ductile iron pipe.		

**PROTECTO 401™ VS. POLYURETHANE**

Test	Protecto 401	Two Component Polyurethane Lining
SALT SPRAY 5% solution ASTM B 117-85	No undercutting at scribe. No damage to panel. 24 months duration	1- 1/2" undercutting at scribe. Damage to panel. 3-3/4 months duration. Test Terminated
TAP WATER IMMERSION 120°F Rated using ASTM D714-87	No undercutting at scribe. No damage to panel. 24 months duration.	3/4" scribe undercut. 2-1/2 months duration. Test Terminated
SODIUM HYDROXIDE IMMERSION 25% solution 140°F Rated using ASTM D714-87	No effect. 24 months.	Softened film, discoloration and etched surface 2-1/2 months, Test Terminated
CATHODIC DISBONDMENT Attached Cell Method ASTM G-95 30 Days/Average 3 samples	0.17 mm disbondment	10.0 mm disbondment
IMPACT RESISTANCE ASTM G-1418-month-old linings. Applied to abrasive blasted Ductile Iron Pipe (non-ground pipe)	72 in/lbs	75 in/lbs
EXTERIOR EXPOSURE Continuous exterior exposure to weather and sunlight. Birmingham, Alabama	2.5 years Chalking, negligible loss of film. No effect on metal protection.	2.5 years Chalking. Negligible loss of film. No effect on metal protection.

HYDROGEN PEROXIDE IMMERSION — 25% Solution		
77°F ASTM D-1308	No effect Passed	Large Blisters Failed
<b>NOTE:</b>		
All materials were tested with an average film thickness of 40 mils on production run ductile iron pipe		

**PROTECTO 401™ VS. SP-2000**

Test	Protecto 401™ Results	SP-2000 Results
<b>UNDERCUTTING RESISTANCE</b> Alternate wet/dry immersion (5%NaCl, flowing, aerated, 120°F, wet 1 hour followed by dry 1 hour- 12 cycles/day) Duration-1 year	Passed – No undercutting at exposed edges	Failed – Severe undercutting at exposed edges (average 15% undercutting)
<b>WEATHERING</b> 1 Year direct exposure Ductile Iron Pipe coupons with cut edges	No Undercutting	Undercutting with 50% disbondment failure
<b>20% SULFURIC ACID RESISTANCE</b> Rated using ASTM D-714 (Measure of Resistance to low PH sewer)	<b>2 years</b> immersion. No effect	<b>30 days</b> – spot test Irreversible chemical change. Coating softened and swells. Coating turns brown.
<b>IMPACT RESISTANCE</b> on ductile iron pipe ASTM G-14	<b>72 in/lbs.</b>	<b>40 in/lbs.</b>
<b>RECOATABILITY</b> (Important to prevent delamination between coats and repair.)	<b>Indefinitely recoatable</b> with itself without roughening of existing coats.	<b>Not recoatable</b> after 24 hour cure without roughening of the surface.
<b>SALT SPRAY ASTM B-117-85</b> 5% SALT @ 98°F	<b>2.0 years</b> No undercutting at scribe.	<b>1.7 months</b> 0.25" undercutting at scribe.
<b>HOT WATER IMMERSION</b>	<b>2.0 years at 160°F</b> No undercutting at scribe.	<b>1.7 months at 140°F</b> 0.25" undercutting at scribe.

**NOTE:**

All materials tested with an average film thickness of 40 mils on production lined ductile iron pipe.

## PROTECTO 401™ VS. SP-2000

	Protecto 401 Ceramic Epoxy	SP-2000
<b>Epoxy Resin</b>	100% Novalac Epoxy <sup>1</sup>	50% Novalac Epoxy <sup>1</sup> 50% Non-Novalac Epoxy <sup>1</sup>
<b>Film Build</b>	60 mils minimum in one coat <sup>3</sup>	12 mils maximum per coat <sup>2</sup>
<b>Recoatability</b>	Recoatable indefinitely with itself <sup>3</sup>	Not recoatable after 24 hours @70°F, Less recoat time at higher temperature <sup>2</sup>
<b>Ductile Iron Pipe Lined History/Usage</b>	25 years/40 million linear feet	Unknown

### INDEPENDENT TESTING:

<b>IMPACT RESISTANCE</b> ASTM D-2794-93	72 in./lbs. <sup>4,5</sup>	60 in./lbs. <sup>5</sup>
<b>ABRASION RESISTANCE</b> ASTM D-4060-90 H-18 wheel 1,000 gram load for 1,000 cycles	.39 Average weight loss <sup>4,6</sup>	.58 Average weight loss <sup>6</sup>
<b>PERMEABILITY</b> ASTM E-96-66	0.00 <sup>4,7</sup>	No independent data
<b>VACUUM TESTING</b> ASTM F-1476-95a	25 inches mercury <sup>4,6</sup>	No independent data
<b>STANDARD TEST METHOD</b> For Effect of Household Chemicals ASTM D-1308	Passed <sup>4,7</sup>	No independent data
<b>RESISTANCE TO CATHODIC DISBONDMENT</b> By The Attached Cell Method – 45 Days ASTM G-95	0.5 mm <sup>4,7</sup>	No independent data
<b>SALT FOG TESTING</b> ASTM B-117	0.0 undercutting <sup>4,7</sup>	No independent test data

<sup>1</sup> Material safety data sheet published by the manufacturer.

<sup>2</sup> Data sheet published by Superior Products for SP-2000.

<sup>3</sup> Quality control records for Protecto 401 Ceramic Epoxy™.

<sup>4</sup> All test data on Protecto 401 Ceramic Epoxy™ as reported was produced by testing production-run ductile iron pipe.

<sup>5</sup> Test commissioned by Superior Products.

<sup>6</sup> Test commissioned by pipe manufacturer.

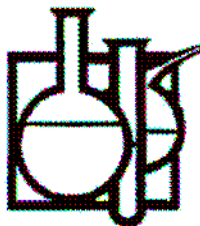
<sup>7</sup> Test commissioned by manufacturer of Protecto 401 Ceramic Epoxy™

**PROTECTO 401**

THE PROVEN CERAMIC EPOXY LINING

888-SPEC-401 | PROTECTO401.COM

**THIRD PARTY TESTING**



## 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/in<sup>2</sup> 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

**INDURON**  
PROTECTIVE COATINGS

**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.

A handwritten signature in black ink, appearing to read 'Wesley Parkhurst Jr.', is written over a horizontal line.

Wesley Parkhurst Jr.

**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

## TOXICITY CHARACTERISTICS OF CURED FILM OF PROTECTO 401™

Cured Films of Protecto 401™ have been independently tested using the [Environmental Protection Agency Method 1311 Toxicity Characteristic Leaching Procedure](#). This procedure is a determination of leachable characteristics of the sample for the following chemicals.

Arsenic	Chloroform	1,4-Dichlorobenzene
Barium	1,2-Dichloroethane	2,4-Dinitrotoluene
Cadmium	1,1-Dichloroethane	Hexachlorobenzene
Chromium	Methyl ethyl ketone	Hexachlorobutadiene
Lead	Tetrachloroethylene	Hexachloroethane
Mercury	Trichloroethylene	Nitrobenzene
Selenium	Vinyl Chloride	Pentachlorophenol
Silver	Toluene	Pyridine
Benzene	o-Cresol	2,4,5-Trichlorophenol
Carbon tetrachloride	m & p Cresol	2,4,6-Trichlorophenol
Chlorobenzene	Cresol (o+m+p)	

Fully cured films of Protecto 401™ do not leach any of these chemicals in an amount which exceeds that allowed by [EPA Test Method 1311](#).

Based on the above testing and a literature search, Protecto 401™, when used to protect sewer lines against corrosion, does not present a health hazard to humans or any risks to the environment.

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 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

**GEORGE MILLS & ASSOCIATES INTERNATIONAL, INC.****HOUSTON**P.O. Box 847 | Humble, 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**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: 205-521-9626  
 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 90 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

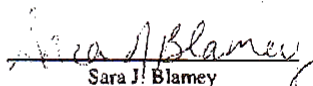
Data: Aerobic Growth Results		
	Replicate	7 Day
Coupon coated in Black Epoxy	1	1
	2	1
	3	1
	4	1
	5	1
	6	1
	7	1
	8	1
	9	1
	10	1
	11	1
	12	1
<b>Average Aerobic</b>		<b>1</b>
Media Control	1	0
	2	0
	3	0
	4	0
<b>Average Media Control</b>		<b>0</b>
Negative Control	1	0
	2	0
	3	0
	4	0
<b>Average Negative Control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

the MiL, Inc. 7259 LANSLOWNE AVENUE SUITE 200 ST. LOUIS MO 63119-3421  
PHONE: (800) 688-9144 FAX: (314) 344-3031

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
<b>Average Aerobic</b>		<b>4</b>
Media Control	1	3
	2	2
<b>Average Media Control</b>		<b>2.5</b>
Negative Control	1	0
	2	0
<b>Average Negative Control</b>		<b>0</b>

Thank you from the staff on project:

  
James J. O'Donnell III  
Laboratory Manager

  
Sara J. Blamey  
Senior Microbiologist II

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**PERMEANCE ASTM E-96**

**COATINGS RESEARCH GROUP, INC.**

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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

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**IMPACT TEST REPORT**  
**PROTECTO 401™ CERAMIC EPOXY**  
 March 2, 1995

GM&A has completed a test program on Protecto 401™ Ceramic Epoxy lined pipe coupons. The results of the completed tests are reported herein. They include the following test procedures:

ASTM G-14: Standard Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).

Coating System: Protecto 401™ CERAMIC EPOXY (Internal) Lining, Plant applied to the internal surface of ductile iron with a reported age in excess of eighteen months.

The conditions of the test include the following: 48 hour minimum temperature and humidity equilibration within the lab at 73°F (23°C). Coupons were approximately 3 x 6 inch with coating applied at a DFT of 33 to 48 mils (825 to 1175 microns). The weight of the falling impactor was 4 pounds. Continuity was determined with a low voltage, wet sponge holiday detector per ASTM G-62. Four panels were evaluated for the test using a Gardner Model #5510 Impact Tester.

TOTAL NUMBER OF IMPACTS:	6	6	8	8
FILM THICKNESS (MILS):	37-39	39-44	33-36	45-48

The impact results using a four (4) pound weight were as follows:

Number of Impacts:	5	5	14	2	2
Number of Pass:	5	5	9	0	0
Number of Fail:	0	0	5	2	2

RESULTS: The average impact strength of the coating as tested was determined to be 72 inch pounds.

CERTIFIED:



Dr. George Mills  
 Date: 2 March 1995

**CERAMAPURE™ PL 90 CERAMIC EPOXY  
 TECHNICAL DATA**



Tested and certified by the  
 Water Quality Association according  
 to NSF/ANSI International Standard 61

**COATING DATA**

**DESCRIPTION:**

A two-component, high solids, chemically cured epoxy coating. Ceramapure™ PL 90 Ceramic Epoxy is a unique and outstanding barrier coating formulated for the protection of ductile iron or steel pipe and fittings.

This product has been certified for cold end uses only by the Water Quality Association to meet the requirements of NSF/ANSI International Standard 61 for potable water immersion service under the following conditions:

Ceramapure™ PL 90 Ceramic Epoxy applied up to 30 mils in one coat. Pipe diameters of four inches or larger.

**PERFORMANCE**

**PANEL: Ductile Iron Pipe      SYSTEM: One Coat Ceramapure™ PL 90 @ 30 mils DFT**

TEST	METHOD/CONDITIONS	DURATION	RESULTS
SALT SPRAY	ASTM B 117 (Scribed)	1 Year	No Blisters or Undercutting
Distilled Water Immersion	77°F (25°C)	1 Year	No Blisters or Undercutting
Impact Resistance (Direct)	ASTM D 2794	1 Year	60 in/lbs, No Cracking
Salt Water Immersion	5% Sodium Chloride Solution	1 Year	No Blisters or Delamination

**LIMITATIONS:**

Do not use for immersion service above 120°F (49°C) or dry heat above 200°F (93°C). Not recommended for immersion in concentrated solutions of mineral acids or organic acids. Not recommended in sewage service.

**SURFACE PREPARATION:**

**Ductile Iron**—Remove all surface contaminants by abrasive blasting. Do not coat surfaces previously coated with asphalt. **Steel (Immersion)**—SSPC-SP 10 Near White Blast. This product does not require scarifying the surface prior to being recoated with itself if recoated within 7 days. Prior to recoating, remove all surface contaminants. When repairing mechanical damage follow printed repair procedure.

**COVERAGE:**

Theoretical— 1,476 ft<sup>2</sup> per gallon at 1.0 mil dry film thickness.

**DRY FILM THICKNESS:**

30.0 mils per coat. Multiple coats may be used if necessary.

**WET FILM THICKNESS:**

33.0 mils

—0908

## APPLICATION DATA

### BLEND RATIO:

One part Ceramapure™ PL 90 Ceramic Epoxy Activator to one part Ceramapure™ PL 90 Ceramic Epoxy Base by volume. Power agitate until components are thoroughly mixed.

### POT LIFE:

One hour at 80°F decreasing with higher temperature .

### APPLICATION:

**Airless Spray**—Use .029 tip; 30 mesh filter; 45:1 Pump ratio at 80-100 psi operating air pressure. **Roll**—Use lambs wool cover. Additional coats may be required to achieve desired film thickness. **Brush**—Use natural bristle brush. Additional coats may be required to achieve desired film thickness.

### THINNING:

None required. Clean equipment with K-1034 Reducer.

### CLIMATE:

Use this product only if the substrate temperature and ambient air temperature is above 45° F and is expected not to decrease for at least two hours after application. Also, the substrate temperature must be 5° F above the dew point for a period of at least two hours after application to avoid condensation occurring on wet paint.

### DRY TIME:

TO HANDLE—10-12 hours at 80°F.

TO RECOAT—50°F or higher, 12 hours; 40°F-50°F, overnight.

NON POTABLE IMMERSION SERVICE—50°F or higher, 7 days with proper ventilation;  
40°F-50°F, 14 days with proper ventilation.

POTABLE WATER IMMERSION—Allow 30 days cure.

**Note:** High film thickness, low temperature and/or poor ventilation will retard dry time.

### PHYSICAL DATA:

VOLUME SOLIDS: 90% ± 2%

SOLIDS BY WEIGHT: 90% ± 2%

WEIGHT PER GALLON: 8.4 ± .2 lbs per gallon (mixed)

VOLATILE ORGANIC CONTENTS:

0.68 lbs/gallon mixed unthinned; 82 grams/liter mixed unthinned

HAZARDOUS AIR POLLUTANTS (HAPS)

.005 lbs/gallon solids mixed unthinned; 0.60 grams/liter solids mixed unthinned

COLOR: Black

### SAFETY DATA:

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

## **CERAMAPURE™ PL 90 CERAMIC EPOXY**

### **Specification Sheet**

#### **A. MATERIAL**

The material must be a two-component epoxy meeting the following requirements. The material shall be equal to Ceramapure™ PL 90 Ceramic Epoxy manufactured by Induron Coatings, Inc., Birmingham, Alabama.

1. The lines will be used for potable water or for feed water in potable water plants; therefore, the following requirements for the material are necessary.
  - a. Must be certified under ANSI/NSF International Standard 61 for potable water immersion service for the size pipe required for the project.
2. The following performance requirements must be equaled or surpassed and documented by the lining material supplier:
  - a. The lining material has to be designed for immersion in fresh, sea and chemically contaminated water on ductile iron pipe and fittings.
  - b. The lining material must be a two-component amine cured epoxy.

#### **B. APPLICATION OF LINING**

##### **1. Condition of Ductile Iron Prior to Surface Preparation**

All ductile iron pipe and fittings shall be delivered to the application 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.

##### **2. Surface Preparation**

The entire interior of the ductile iron pipe from the bottom of the gasket groove and around the exterior of the spigot end for 6" back from the spigot end shall be delivered to the lining application sight free from asphalt coating. Any areas where grease or oil is present shall be cleaned using the SSPC-SP 1 Solvent Cleaning method. After the surface has been made free of grease, oil, etc., the entire surface described above shall be abrasive blasted at a rate so as to remove all loose foreign materials, which would adversely affect the bond of the lining material to the pipe surface. Since some oxides present after manufacture of ductile iron pipe are tightly adhering to the surface and thus become an integral part of the surface, the intent of this specification is to strike the entire surface of the pipe to be coated with the blast media with sufficient force so as to impart a uniform color to the surface with the absence of all red rust and loose oxides. All prepared surfaces should receive the specified protective compound within the same day of surface preparation. If rusting is visible prior to lining, the entire surface must be reblasted.

##### **3. Qualification of Applicator and Workmen**

A competent firm with a five-year history of lining ductile iron shall apply the lining compound. The workmen employed by the applicator shall be experienced and competent in the application of the pipe lining and shall have been trained in the application and inspection of the compound to be applied. He shall also be financially responsible, having a net worth of at least the amount of his contract.

##### **4. Equipment**

All application equipment shall be as recommended by the supplier of the lining compound.

##### **5. Atmospheric and Substrate Conditions**

The pipe surface areas to be coated shall be blown-off with air to remove all sand, dust and other compounds. Any grease or oil shall be removed by solvent cleaning. The compound shall not be applied when the ambient or substrate temperature is below 45° F. The compound shall not be applied under adverse atmospheric conditions that will cause detrimental blistering, pinholing or porosity of the film.

**6. Application Technique and Film Thickness**

The lining compounds shall be thoroughly mixed according to the recommendations of the supplier. After blasting and cleaning, the compound shall be applied to the interior of the pipe so as to obtain a continuous and relatively uniform and smooth integral lining. The material shall be applied to yield a total minimum dry film thickness of 30 mils for the complete system. The spigot ends and bottom of the gasket groove shall be coated as follows: The first 6" of all spigot ends and the bottom of the gasket groove shall receive a lining of

Ceramapure™ PL 90 Ceramic Epoxy applied to yield a film thickness of 4.0 mils minimum to 6.0 mils maximum dry film thickness. This lining shall be applied directly to the ductile iron.

Where application is commenced, the complete operation shall be completed as soon as practicable, without prolonged delays. After application, the pipe and pipe surfaces shall be protected from damage or contamination by water, excessive dust or other contaminants until it is tack free.

**C. PLANT INSPECTION****1. Pipe Identification**

Each pipe joint shall be marked with the date of application of the lining system completed and inspected in accordance with these specifications, and with its numerical sequence of application of that date. A permanent marker of a light blue color shall be used to place a 2"x2" square on either the inside or outside of the pipe or fitting along with the statement "For Potable Water Only".

**2. Thickness Inspection**

Each pipe shall be checked for thickness using Steel Structures Painting Council SSPC-PA2 Film Thickness Testing.

**3. Testing**

The barrel of all pipe shall be tested for pinholes using a 2000 volt non-destructive pinhole detection test. All detected pinholes shall be repaired prior to shipping.

**4. Repair**

All damaged lined areas, holidays, and thickness test shall be repaired in accordance with the manufacturer's recommendations so that the repaired area is equal to the undamaged lined areas in all respects.

**5. Approval by Engineer**

Prior to loading for shipment the Engineer or his representative may inspect and approve the lining application on all pipe. Any work not conforming to the above specification shall be repaired to conform therewith before being loaded for shipment to the job site.

**6. Drying Time Prior to Immersion**

Lining surfaces shall be permitted as long a drying time as practicable, but in any event, until the final coat has dried at least 7 days. Minimum drying periods may be required to be increased substantially if the drying temperature is below 65° F. For potable water, the product should not be immersed for 30 days.

**7. Shipping and Handling**

Equipment used to handle and transport the lined pipe shall be suitably designed and operated so as to not damage the compound. Any damage that may occur must be repaired prior to installation of the pipe in accordance with the manufacturer's recommendations so that the repaired area is equal to the undamaged lining in all respect except cosmetically. 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.

## **PROCEDURES FOR REPAIRING FIELD DAMAGED AREAS OF CERAMAPURE™ PL 90 EPOXY FOR INTERIOR POTABLE WATER SURFACES**

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, chalking, 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 coated area before patching. Be sure to roughen and overlap at least 1" of lining in the area to be repaired.
4. With the area to be sealed or repaired cleaned and suitably roughened, apply a coat of Ceramapure™ PL 90 Ceramic Epoxy using the following procedure:
  - a. Mixing Procedure—Ceramapure™ PL 90 Ceramic  
Epoxy is a two-component epoxy consisting of two cans labeled Part A Base and Part B Activator. Add the contents of Part B Activator into the contents of Part A Base. Immediately mix thoroughly. Mixed material must be used within one hour of mixing at 80° F decreasing with higher temperature. For smaller quantities, mix components at a 1:1 blend ratio.
  - 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 lining are contained in the technical data sheet for Ceramapure™ PL 90 Ceramic Epoxy. 0108