AZZ Galvanizing Services

Kevin Irving
Central Marketing Manager
kevinirving@azzgalv.com
815-693-4242

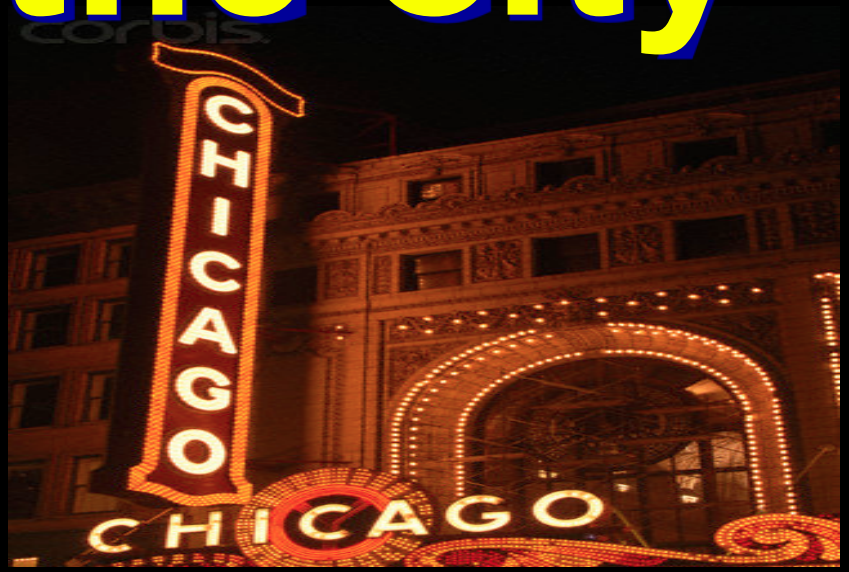
The Corrosion Problem

25-30% could be eliminated if adequate corrosion protection systems were employed

Guide Rail

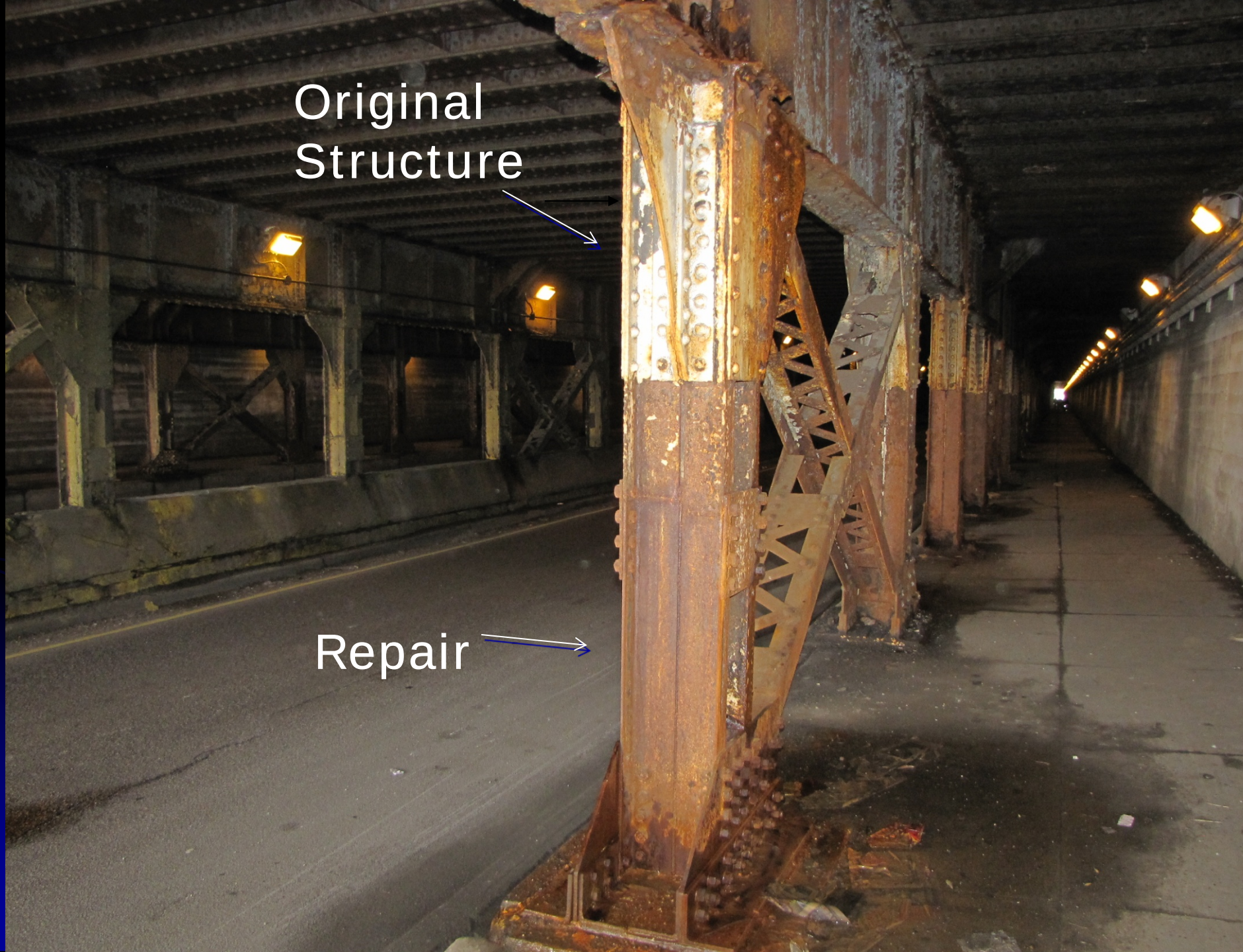
The Corrosion Problem

Tour of the City




Canada 1/4
Clark Ave 1
nois Ave. 1 3/4


738


Original
Structure
Repair


24
50
142
Sarpinos
www.gosarpinos.com

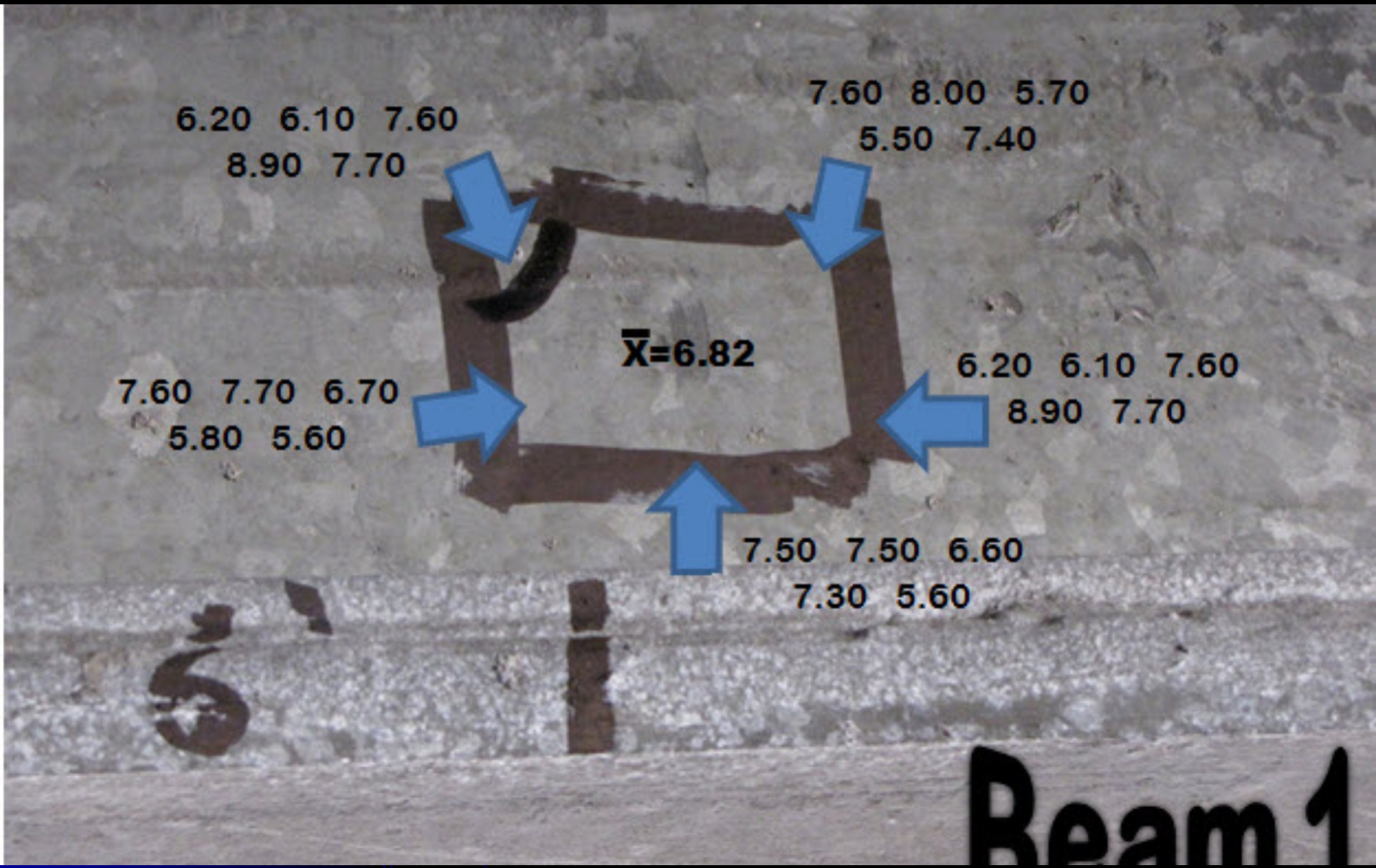
Bridge No.	04745	**Inspected by:**	Mike Long
Town:	Norwich	**Inspected by:**	Mike Holdridge
Feature Carried:	Pleasant Street	**Date Inspected:**	09/11/2014
Feature Crossed:	Yantic River	**Project No.:**	

Photo # 11:
West elevation.(Inlet)

Photo # 12:
View upriver.

Corrosion Protection

I-69 Bridge


6.20 6.10 7.60
8.90 7.70
7.60 8.00 5.70
5.50 7.40
$\bar{X}$=6.82
7.60 7.70 6.70
5.80 5.60
6.20 6.10 7.60
8.90 7.70
7.50 7.50 6.60
7.30 5.60
Beam 1

New Galvanized Bridges in Chicago

- 35th Street & Dan Ryan 362 Tons
- 51 Street & Dan Ryan 349 Tons
- Douglas Lake Connection 1444 Tons
- 57th Street & Dan Ryan 346 Tons
- 67th Street & Dan Ryan 403 Tons
- Michigan Ave over I-94 234 Tons
- 91st Street & Dan Ryan 234 Tons
- 26th Street & Dan Ryan 194 Tons

CTA , IL Toll Road, IDOT & Counties

Over 72 Million Pounds of Bridges were Galvanized in Illinois in last 5 years.

Tappen Zee Bridge

Tappen Zee Bridge

Law of Entropy

- Tendency for metal, after production and shaping, to revert back to its lower, more natural energy state or ore

Definition of Corrosion

- *Corrosion (n)*: the chemical or electrochemical reaction between a material and its environment that produces a deterioration of the material and its properties

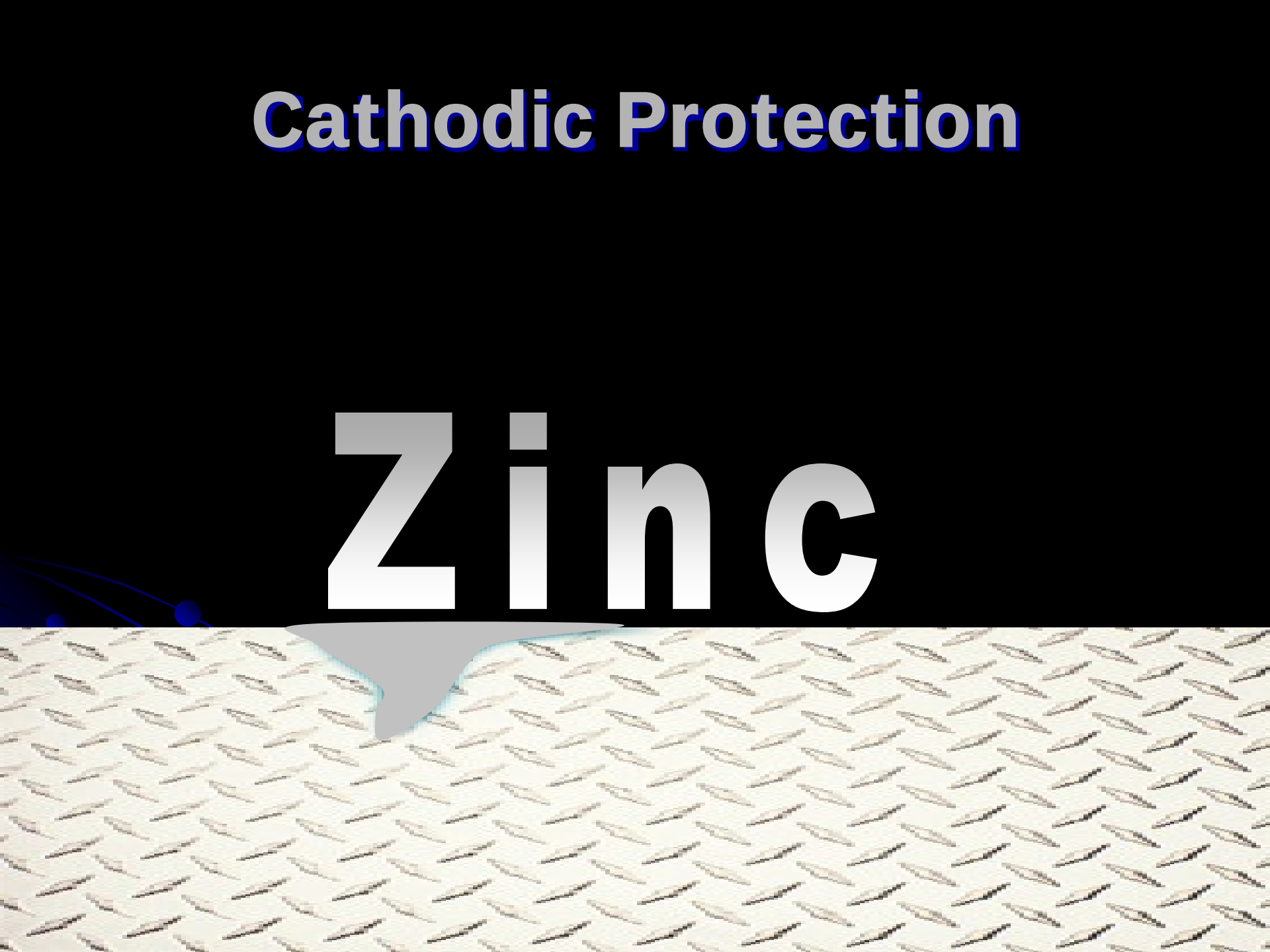
The Solution

Long-Lasting Zinc Protection

- Barrier
- Cathodic
- Zinc Patina
- Metallurgical Bond

Barrier Protection

Cathodic Protection



Galvanic Series of Metals

ZINC = ANODE

STEEL = CATHODE

This arrangement of metals determines what metal will be the anode and cathode when the two are put in a electrolytic cell (arrangement dependent on salt water as electrolyte).

Zinc Patina

Zinc Carbonate

Zinc Hydroxide

Zinc Oxide

Zinc

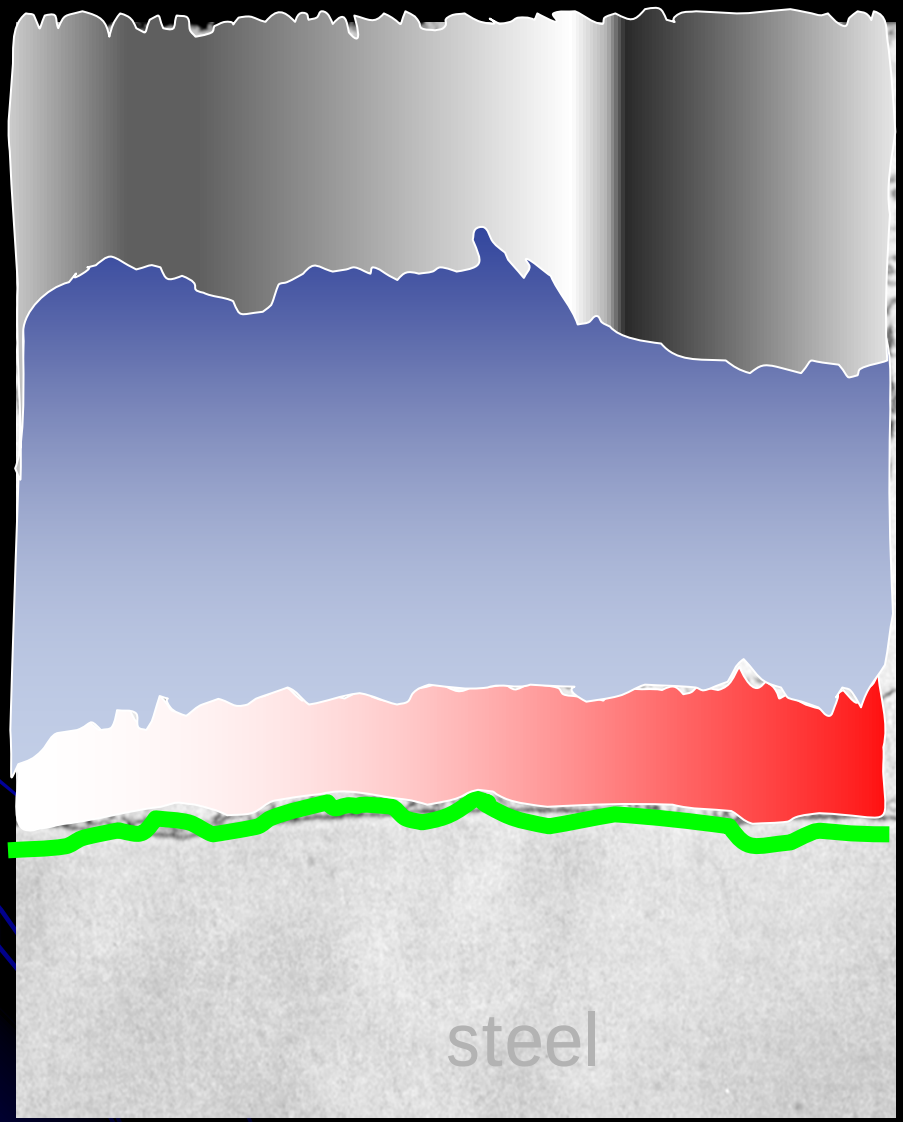
Metallurgical Bond

Eta

Zeta

Delta

Gamma

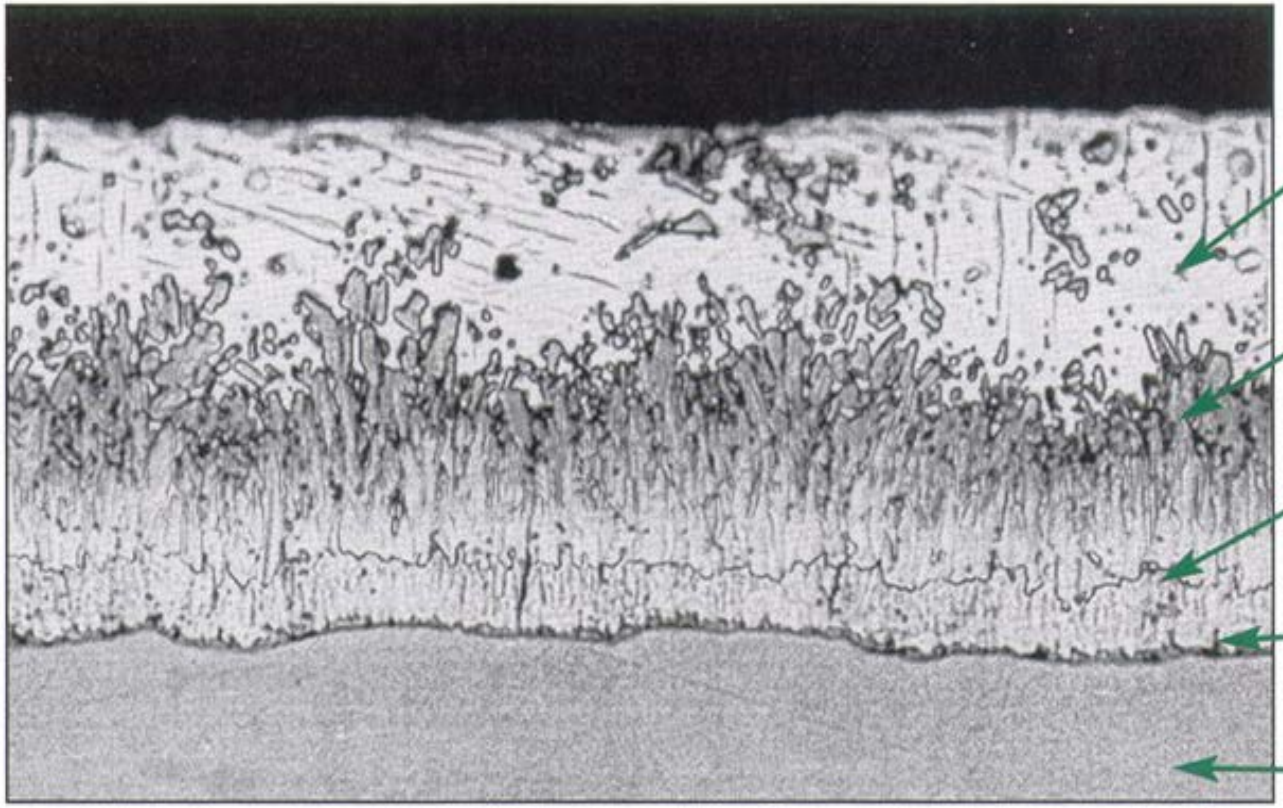


100% Zinc

94% Zinc
6% Iron

90% Zinc
10% Iron

75% Zinc
25% Iron



Eta
(100% Zn)
70 DPN Hardness

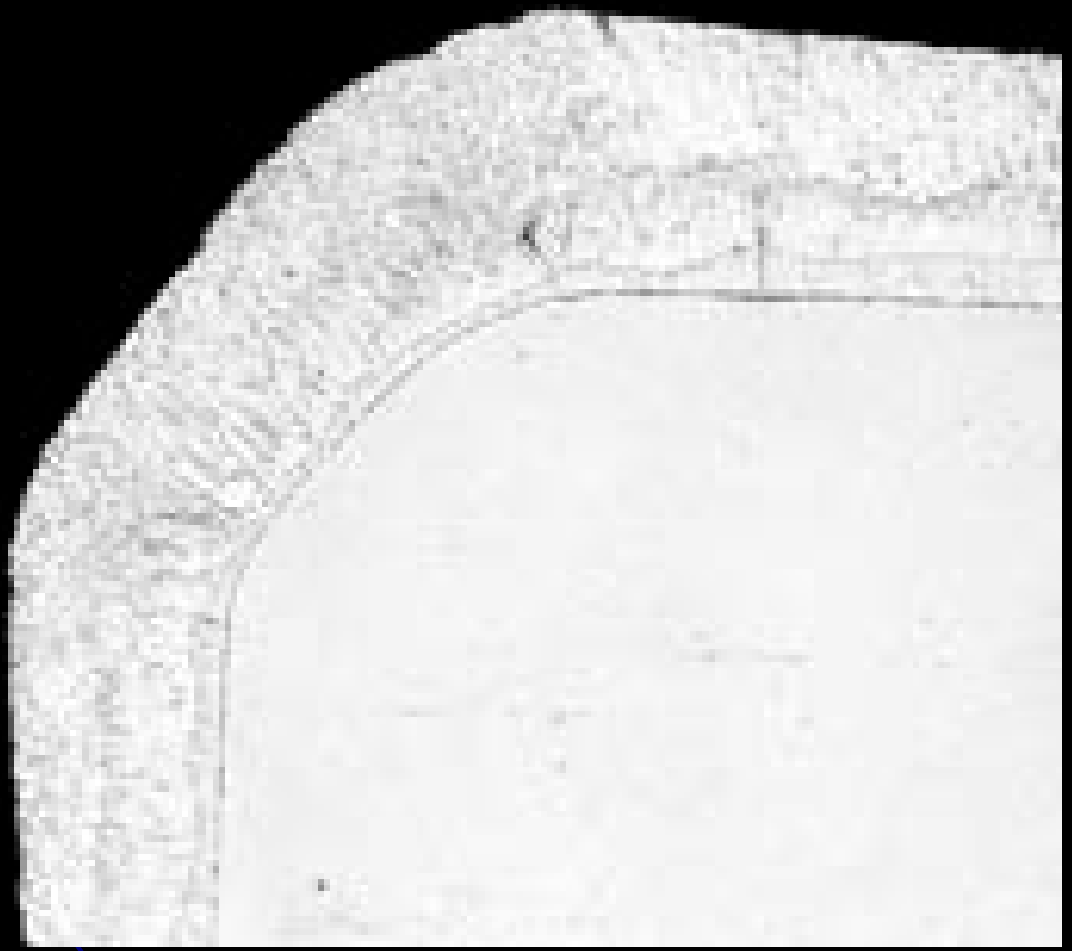
Zeta
(94% Zn 6% Fe)
179 DPN Hardness

Delta
(90% Zn 10% Fe)
244 DPN Hardness

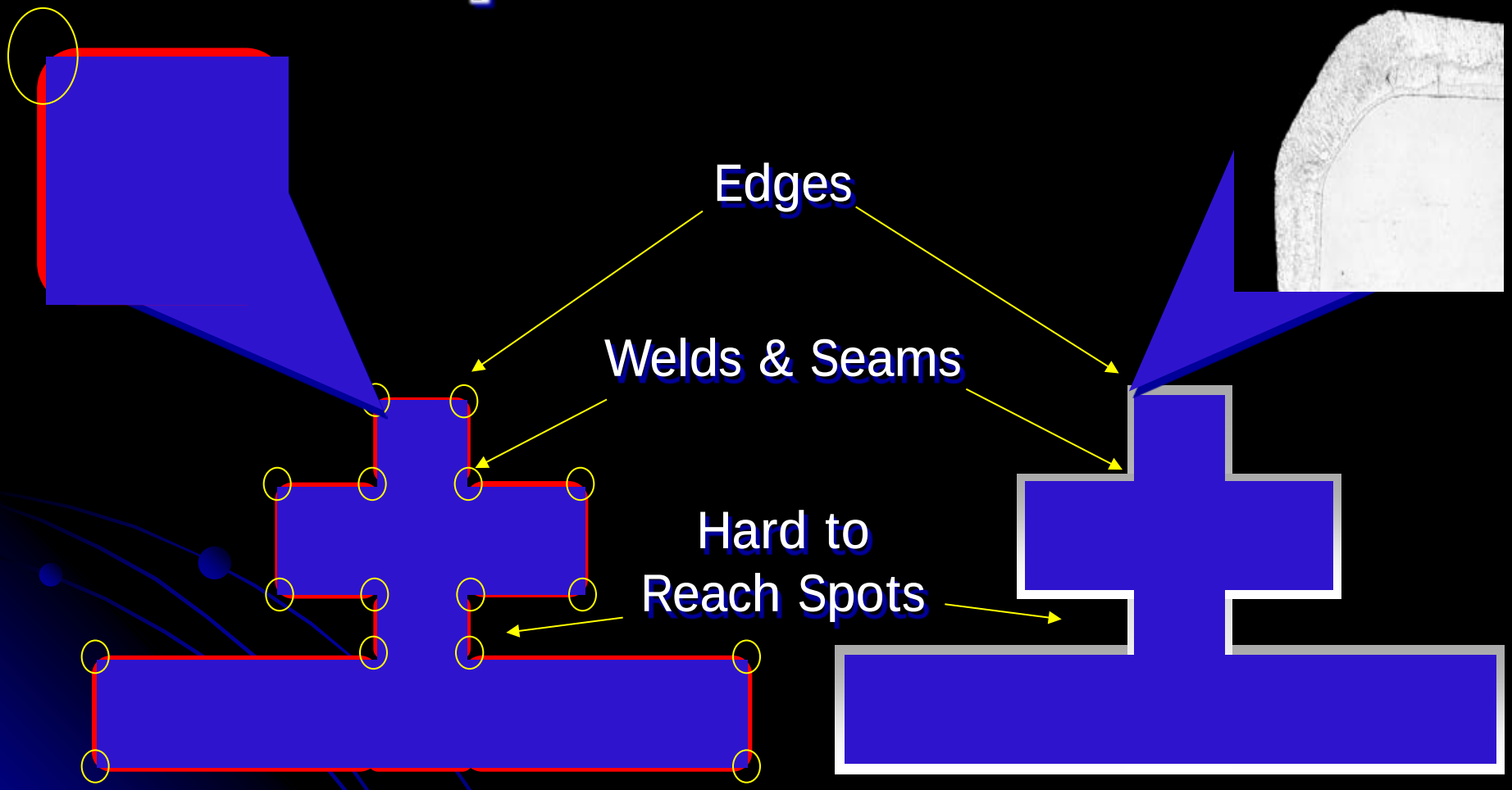
Gamma
(75% Zn 25% Fe)
250 DPN Hardness

Base Steel
159 DPN Hardness

Edge Protection



Complete Protection



Typical Spray Application

Hot-Dip Galvanizing

Galvanizing Process

HDG Process: Surface Preparation

- Thorough cleaning is necessary as zinc will only adhere to clean steel
  - **Degreasing** – removes dirt, oils, organic residue

Degreasing Tank

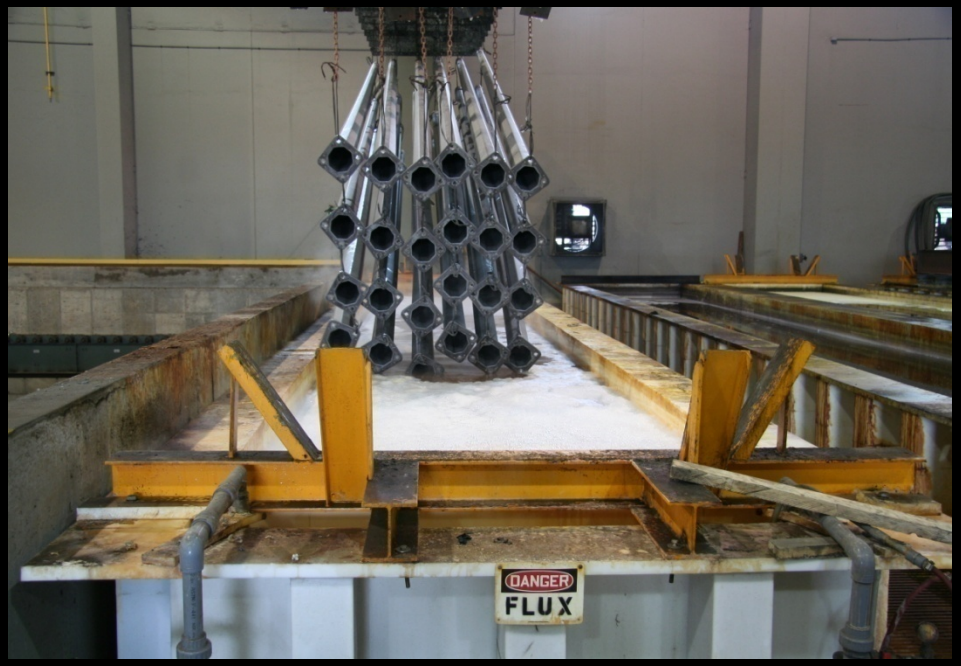
HDG Process: Surface Preparation

- Thorough cleaning is necessary as zinc will only adhere to clean steel
  - **Degreasing** – removes dirt, oils, organic residue
  - **Pickling** – Removes mill scale and oxides

Pickling Tank

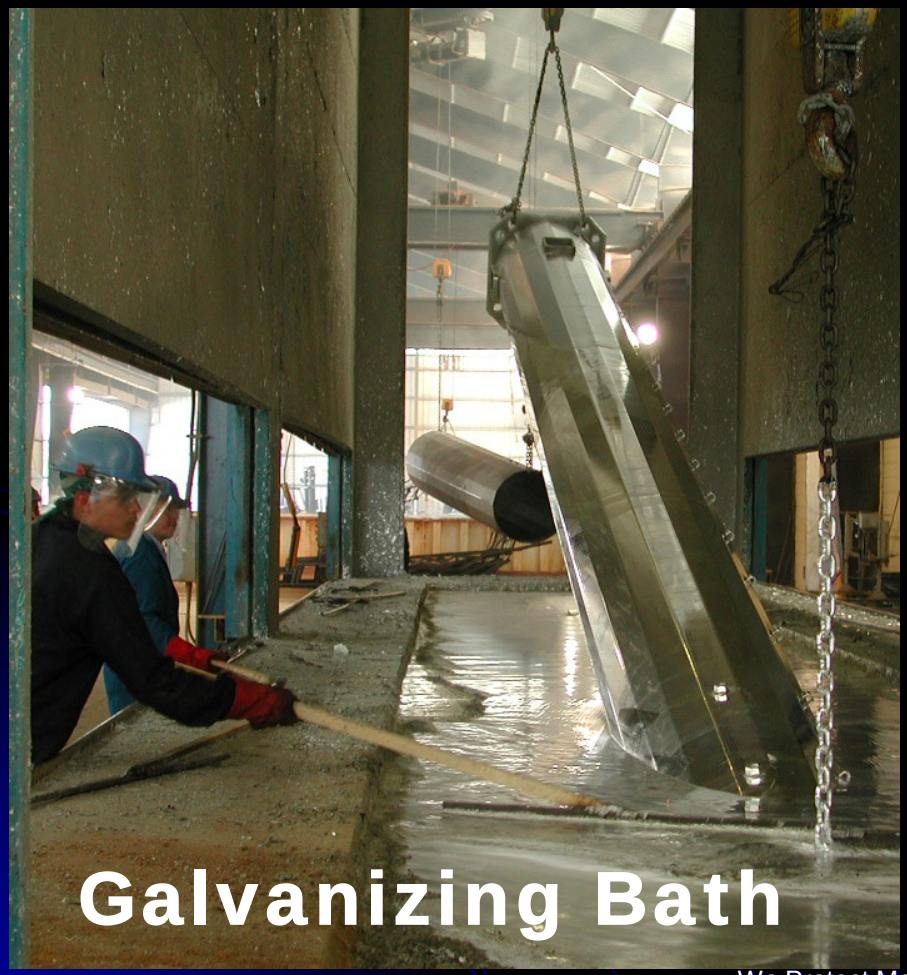
HDG Process: Surface Preparation

- Thorough cleaning is necessary as zinc will only adhere to clean steel
  - **Degreasing** – removes dirt, oils, organic residue
  - **Pickling** – Removes mill scale and oxides
  - **Fluxing** – Mild cleaning, provides protective layer

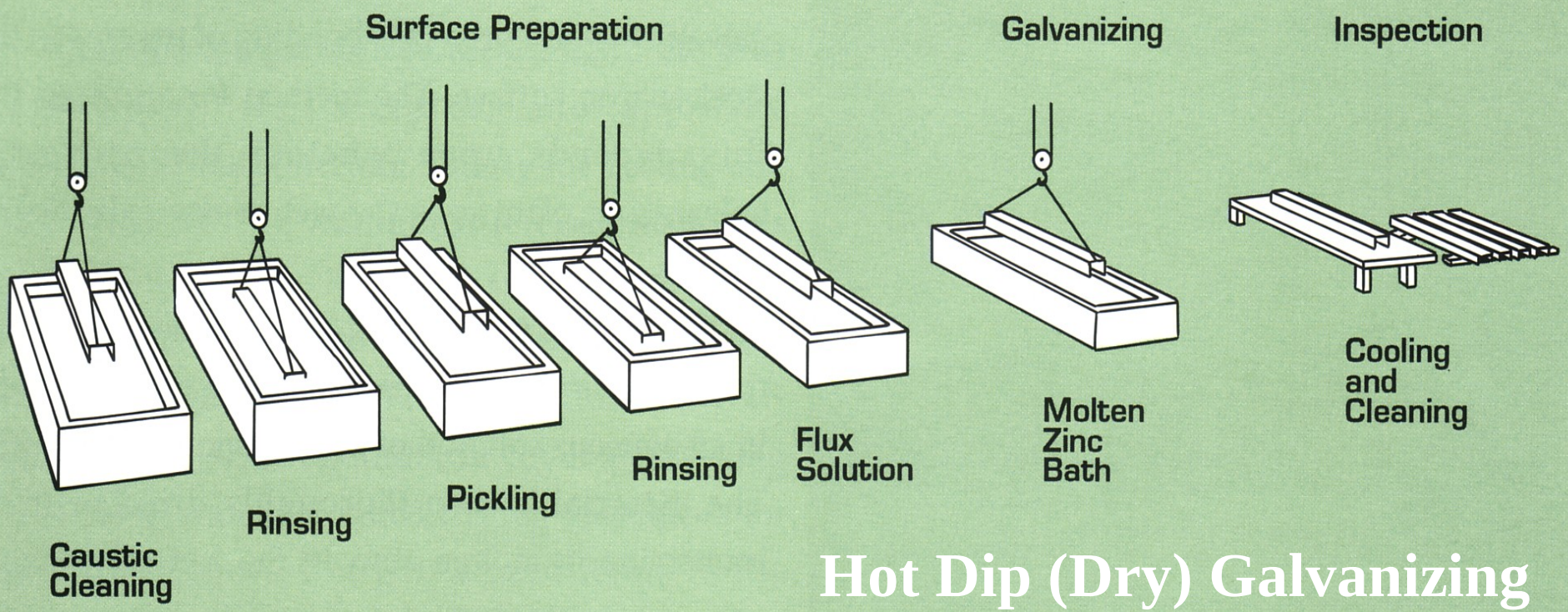


Flux Tank

HDG Process: Galvanizing



- Steel immersed in bath of molten zinc (~830 F)
- > 98% pure zinc, up to 2% additives (Al, Bi, Ni)
- Zinc reacts with iron in steel to form coating
- Reaction is complete when steel reaches bath temperature



Hot Dip (Dry) Galvanizing

HDG Process: Inspection

- Steel is inspected after galvanizing to verify conformance to specs
- Visual inspection to identify any surface defects
- Magnetic thickness gauge to check coating thickness

Va zes & Shapes

It’s Recyclable

Sustainability: Galvanizing is Green

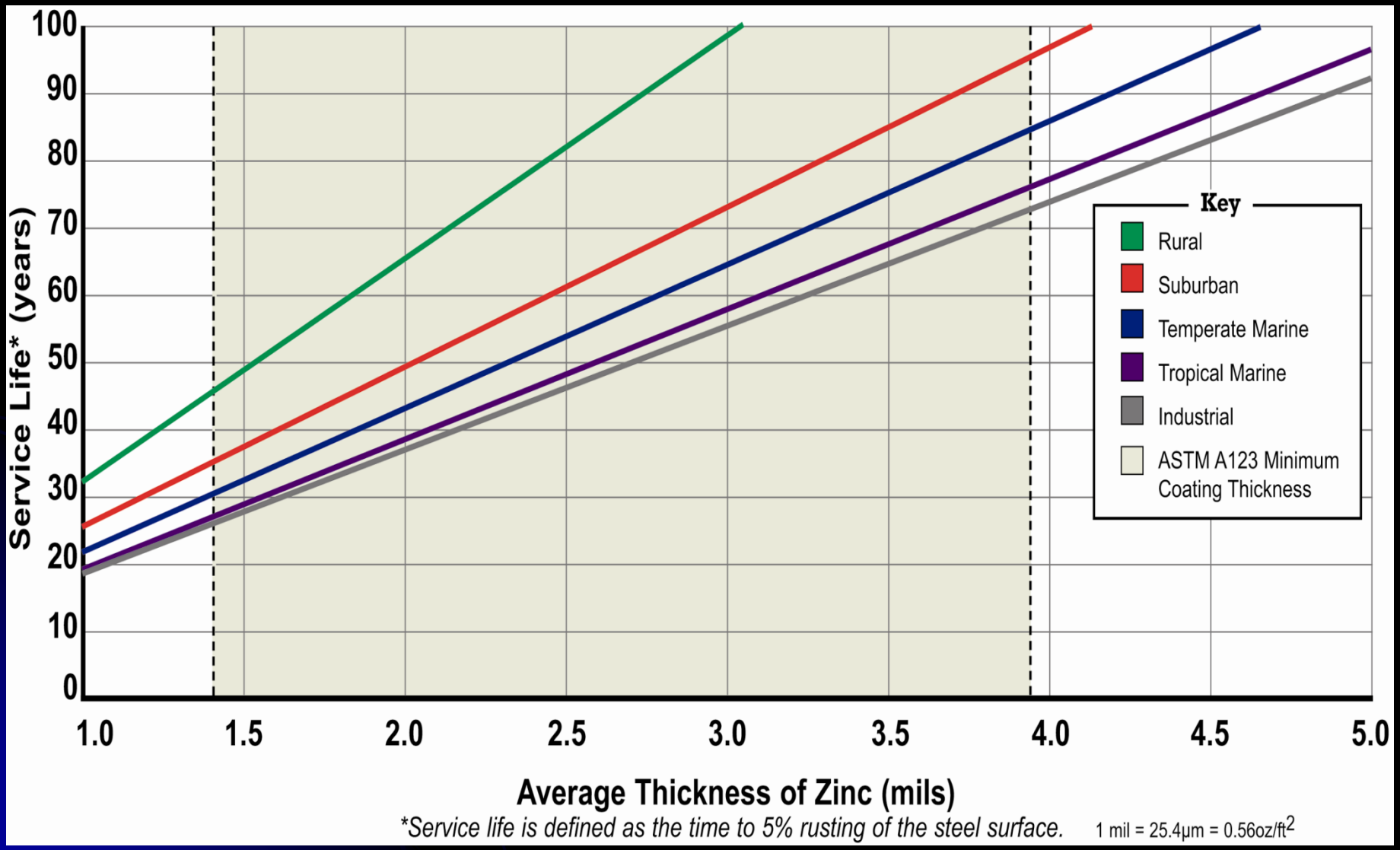
- Zinc and steel are 100% recyclable
  - Properties of zinc (and steel) do not degrade with reprocessing
  - Zinc is a natural element in the Earth's crust
  - Recycled content contributes to LEED
- Galvanizing's maintenance-free durability ensures no additional energy, materials, or emissions during use

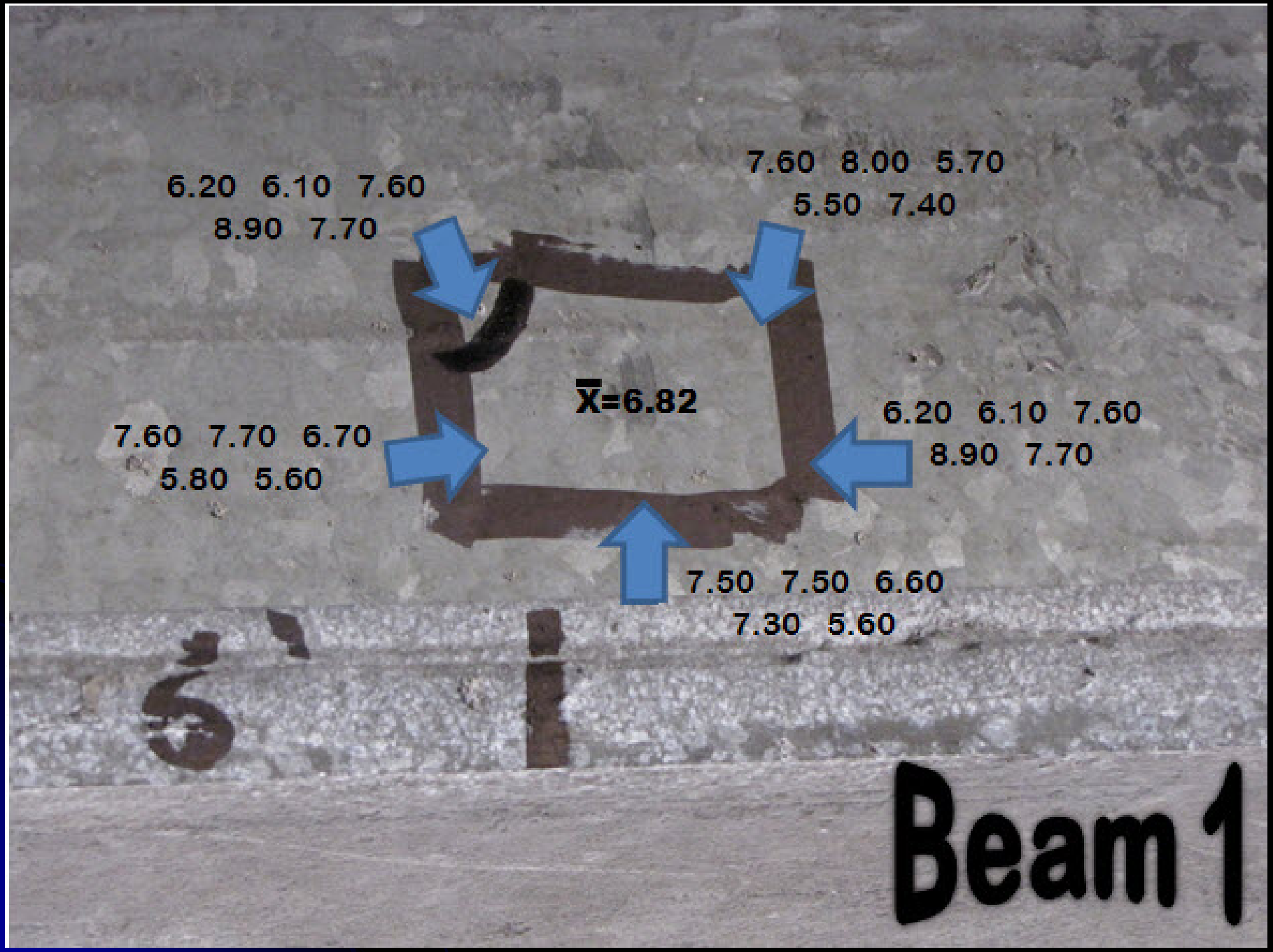

VOCs
No Volatile Organic Compounds

Zinc Coating Life Predictor

- Anticipates service life
- Program performs calculations
  - Statistical methods
  - Neural network technology
  - Worldwide corrosion database
- Atmospheric categories
  - Rural
  - Suburban
  - Temperate marine
  - Tropical marine
  - Industrial

Estimated Service Life of HDG

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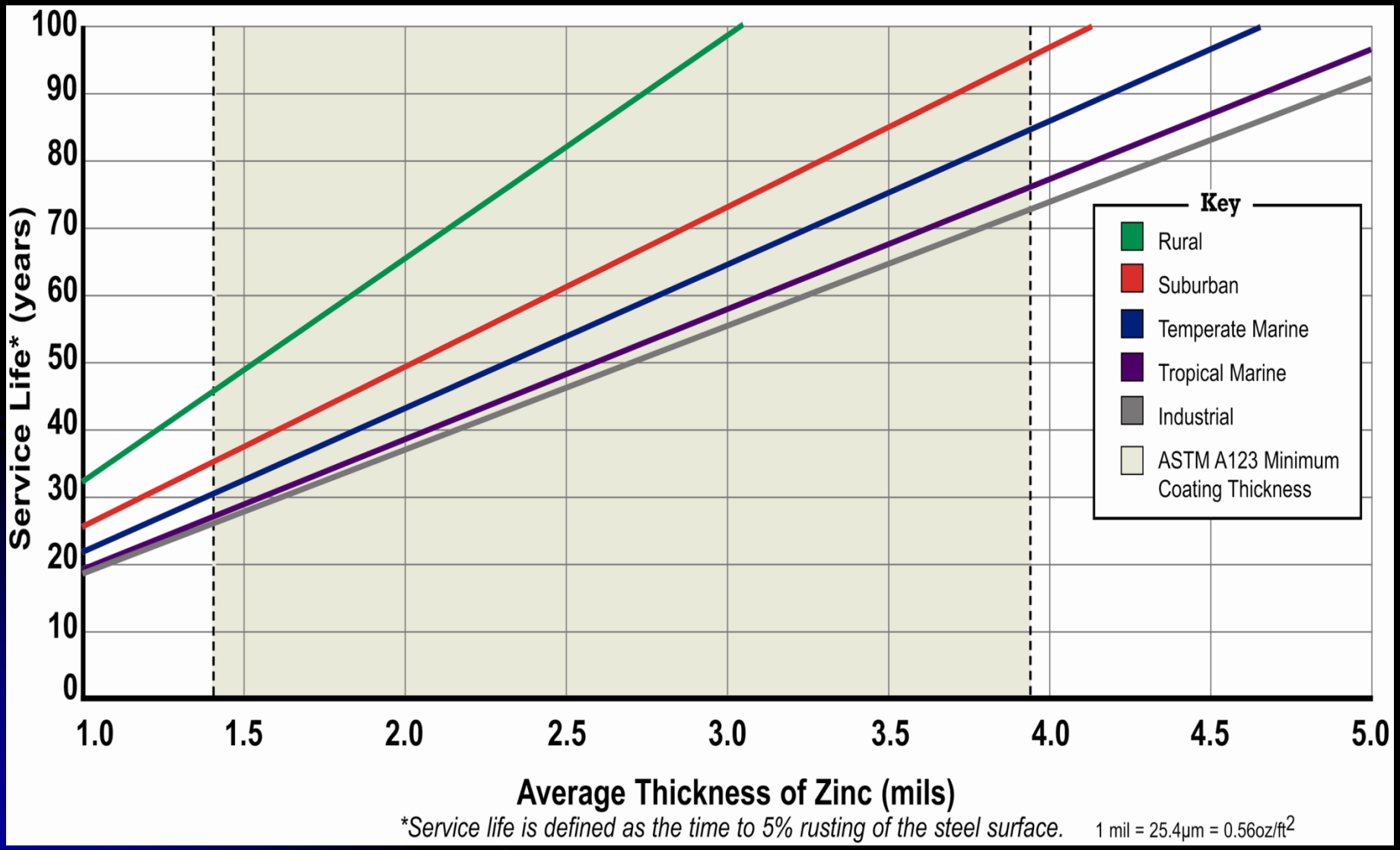
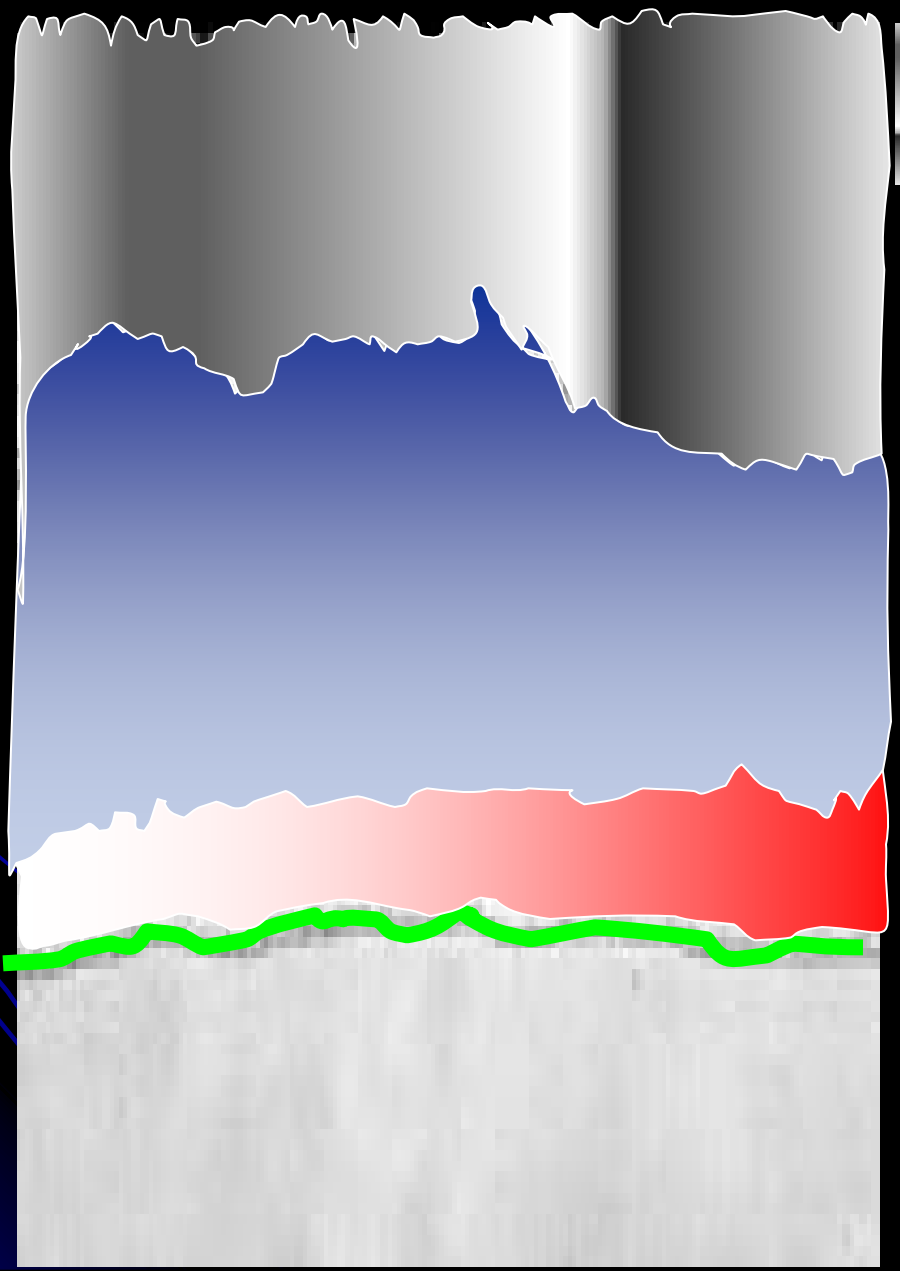
7.30 5.60
Beam 1

Estimated Service Life of HDG



Metallurgical Bond



Eta

100% Zin

Zeta

94% Zinc
6% Iron

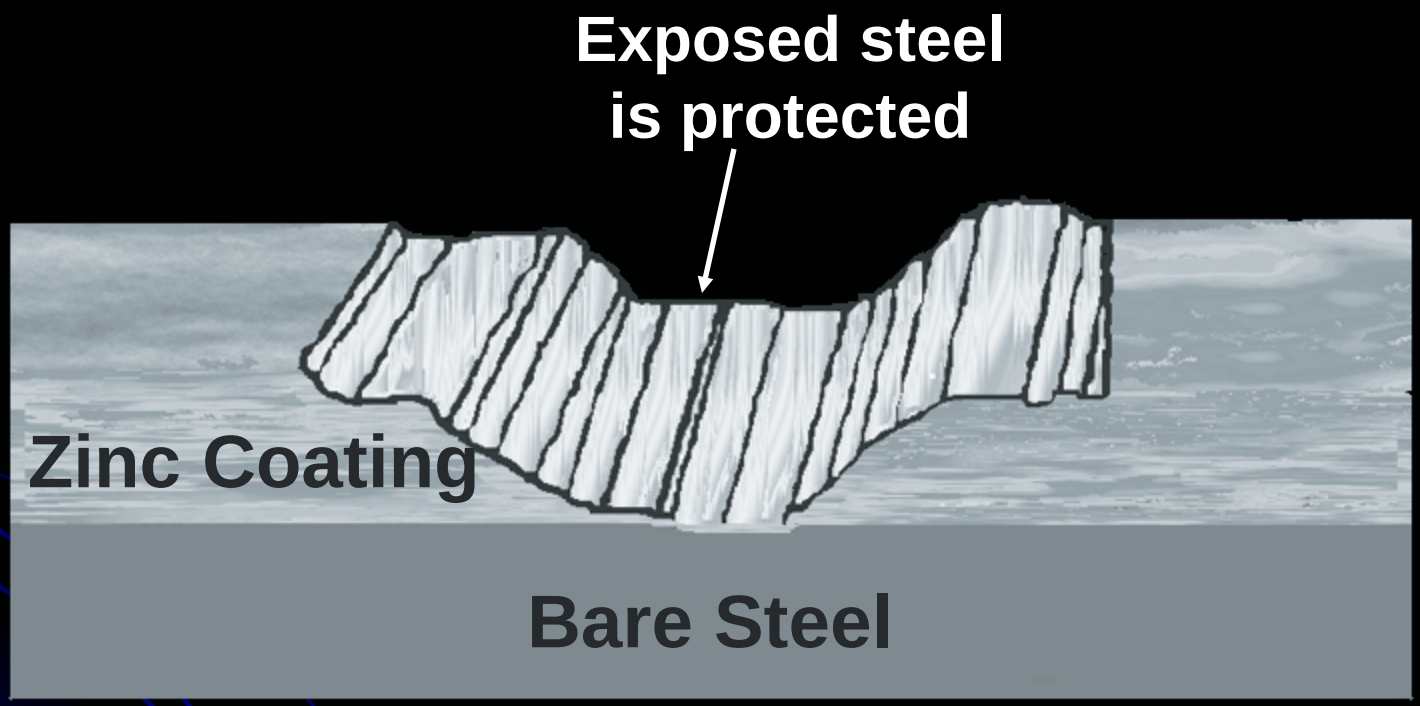
Delta

90% Zinc
10% Iron

Gamma

75% Zinc
25% Iron

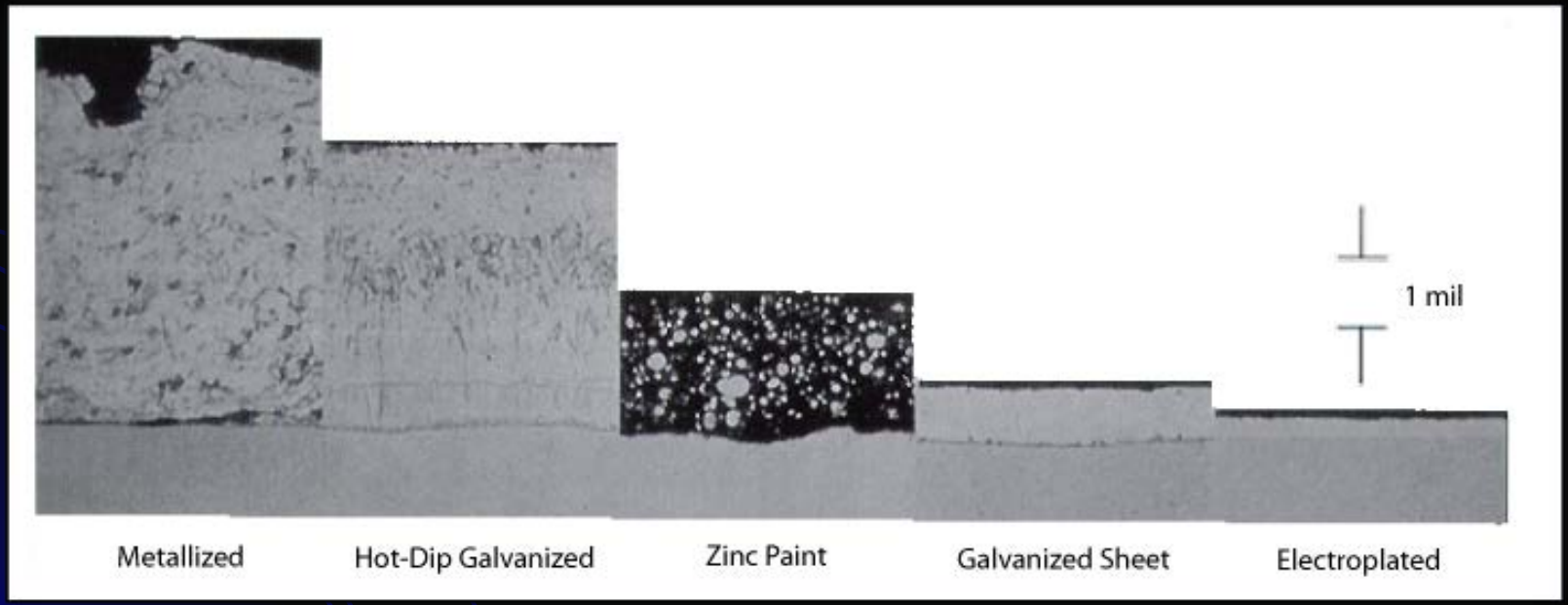
Cathodic Protection: Sacrificial Zinc



Even damaged areas of the coating will be cathodically protected by surrounding zinc

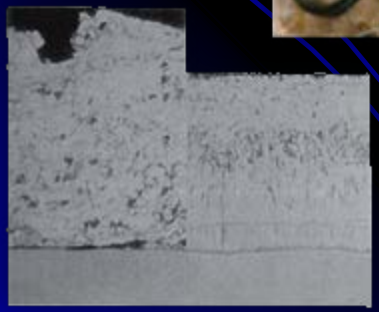
Other Zinc Coatings for Corrosion Protection

Zinc Coatings Comparison



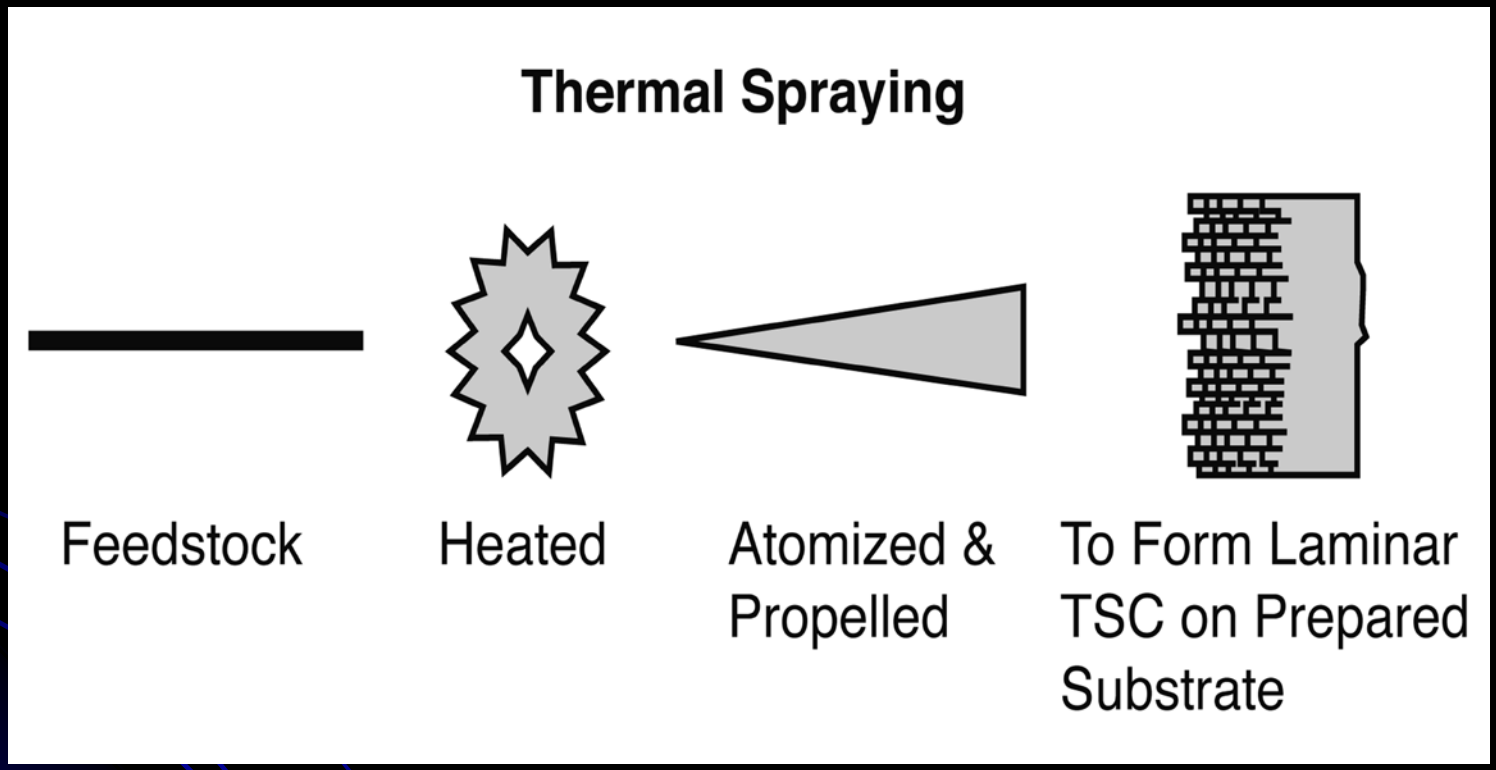
Metallizing

- Zinc wire or powder melted and sprayed onto the surface
- Shop or field application
- 85% as dense as HDG
- Mechanical bond and no alloy layers



Metallized Hot-Dip Galvanized

What is Thermal Spray?



Twin Wire Arc Process Description

Electrically Charged Wires, one Positive and the other Negative

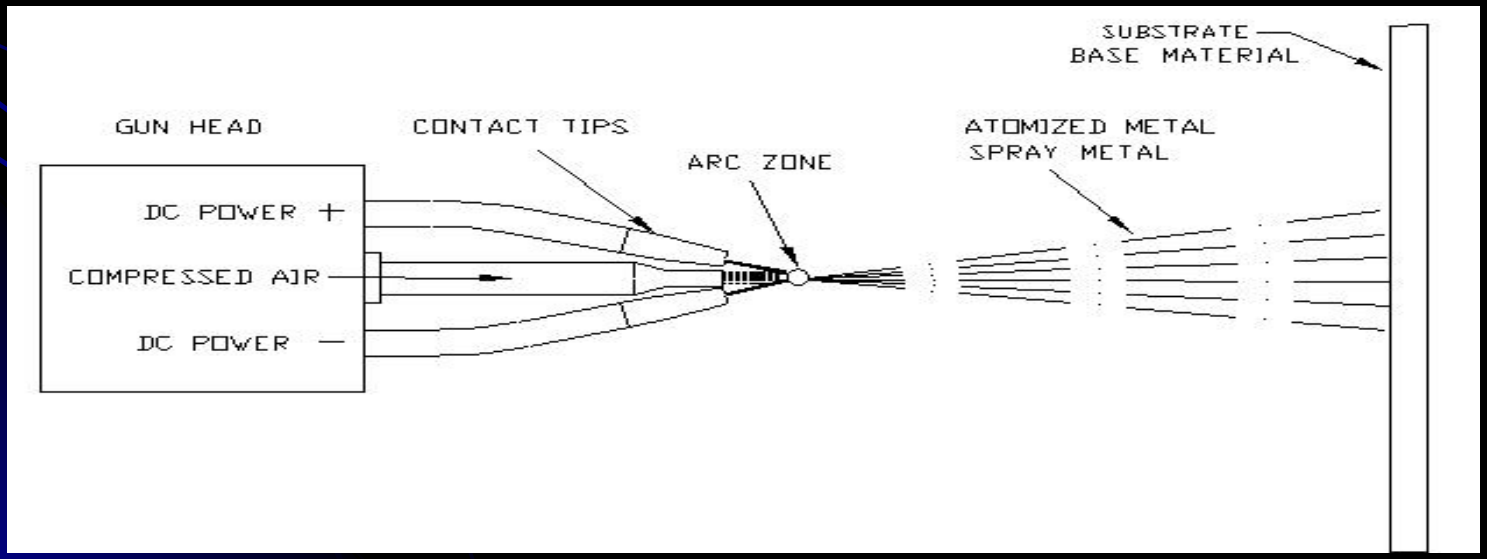
Charged Wires Meet at the Gun Head and Create an Arc

Molten Metal Propelled to Substrate with Compressed Air

Molten Metal Solidifies in flight /Rapidly Cools on Contact with Substrate to Form Protective Sacrificial Coating

Substrate Heating Minimal (Thin Coating, Thick Substrate)

No Cooling or Curing of Coating Required (Ready for Immediate Service)



TSC Applied to Girders for Atmospheric Service

Thermal-Spray Coated Cross Frames

Surface Prep

(Coating Adheres thru a Pure Mechanical Nature)

- SP 5/ SP 10, White Metal or Near White Metal Blast
- Anchor Profile is needed –Min. 3mils
- No Contaminants Present
- Sharp Angular Grit, No Round Shot
- Garnet, Kleen Blast, Green Diamond, Aluminum Oxide to name a few

b

Thomas Mathis Bridge by New Jersey DOT

Ridge Avenue Bridge in Philadelphia

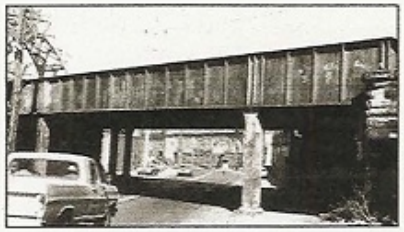
Ridge Avenue Bridge

After 58 Years, the Zinc Keeps On Working

METALLIZED IN THE 1930'S.....

The Ridge Avenue Overhead Bridge was constructed in 1916 by the Phoenix Bridge Company for the Philadelphia Railroad. In 1937, the underside of the bridge was blasted to white metal and then metallized with 10 to 12 mils of pure zinc to create a galvanic zinc anode system to protect against corrosion.

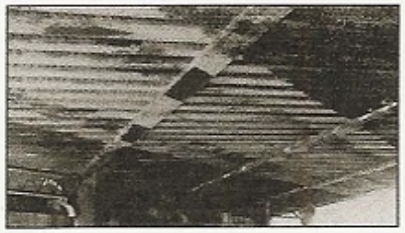
It was believed that the bridge was dismantled in the early 1990s. To our surprise, we found that the bridge was still standing, in constant service and in about the same condition that we chronicled in 1987. The zinc coating is still visible on the underside.



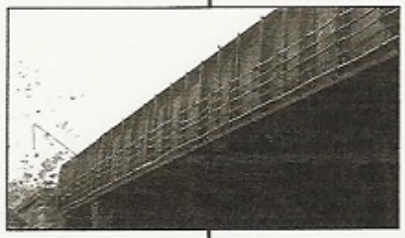
Ridge Avenue Railroad Bridge

Applicators on Ridge Avenue Mid 1930's

The location of this railroad bridge is a highly industrialized part of Philadelphia, making the environment extremely corrosive. When a zinc coating is applied to a properly prepared steel substrate, the design life of the structure is extended. The expected life of a zinc coating is normally 25-50 yrs. depending on the environment , mil thickness, topcoat and quality of the application.



Cleaning in 1987



Visit in 1995

In 1987, a portion of the underside was cleaned, exposing the original zinc coating (the lighter streak shown in pictures).It was discovered that a significant amount of zinc remained, continuing to protect the steel.

The Ridge Avenue Bridge is a structure that is *not* aesthetically pleasing - not the type of structure one would use as the hallmark for a coating system. **However, there are few systems that protect a steel structure for 58 (and counting) years for $.005 per square foot per year.**

Memorial Bridge

“Worlds First” Cold-Bent Curved Truss Flange

Rt 30 over I-80

Whittier Bridge

Metallizing Service Life

- Rural **33 years**
- Moderate Industrial **22 years**
- Heavy Industrial **16 Years**

Other Zinc Coatings

Metallized

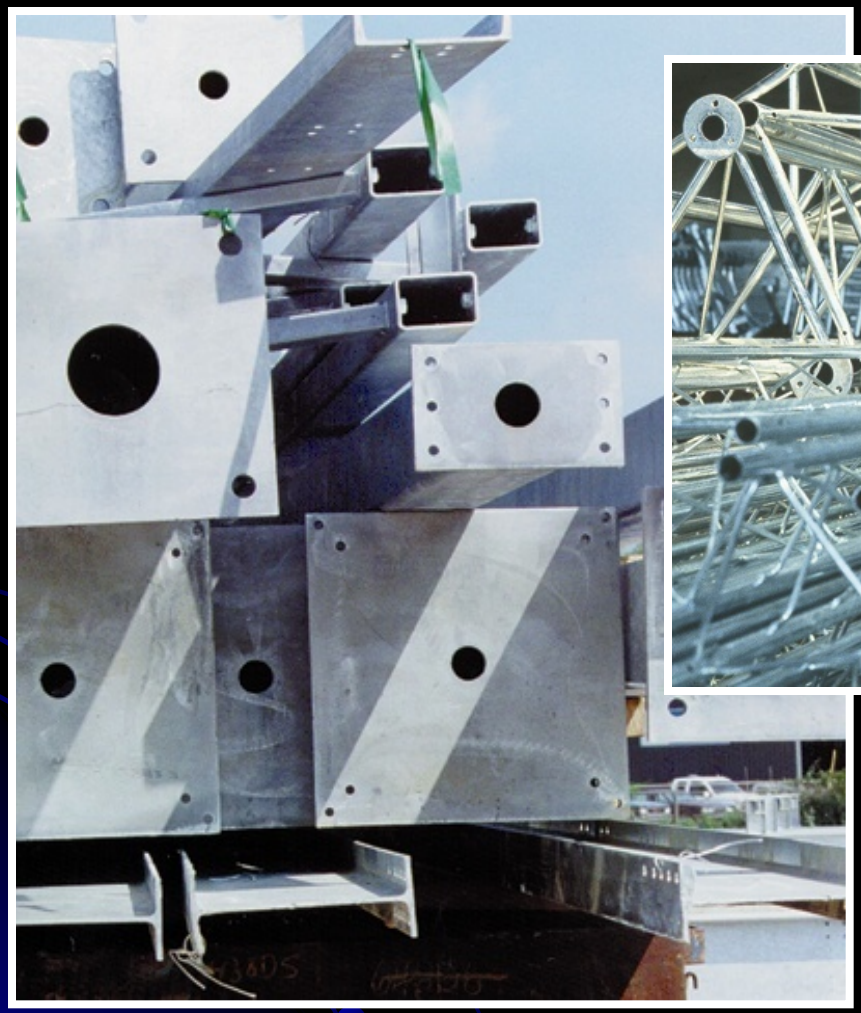
Hot-Dip Galvanized

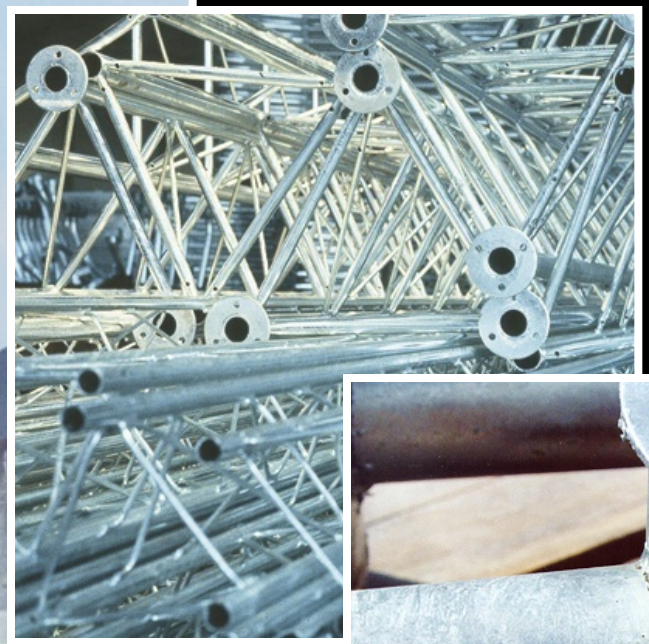
ized

1 mil

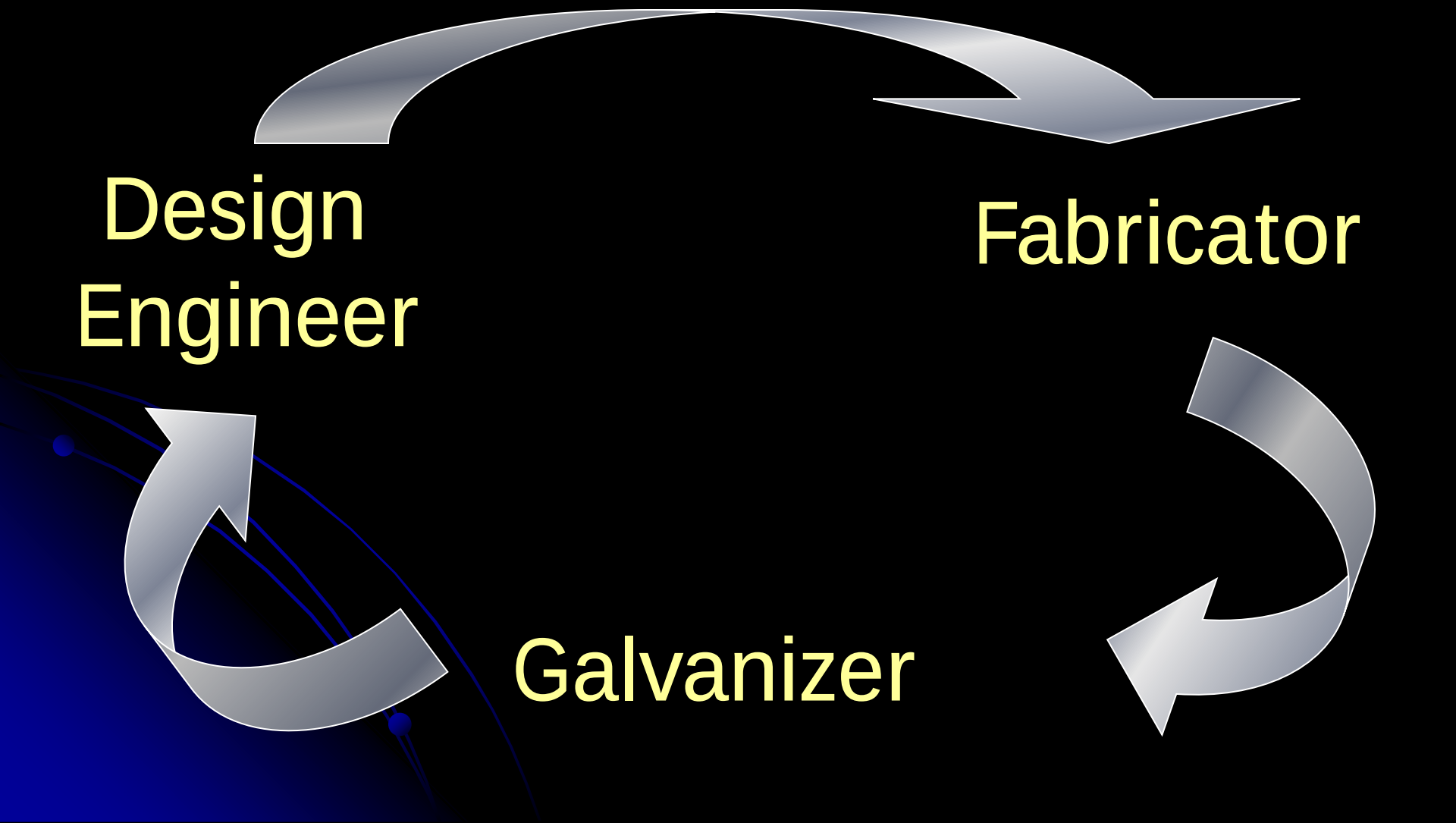
Electroplated

Design & Fabrication





Liaison Between...

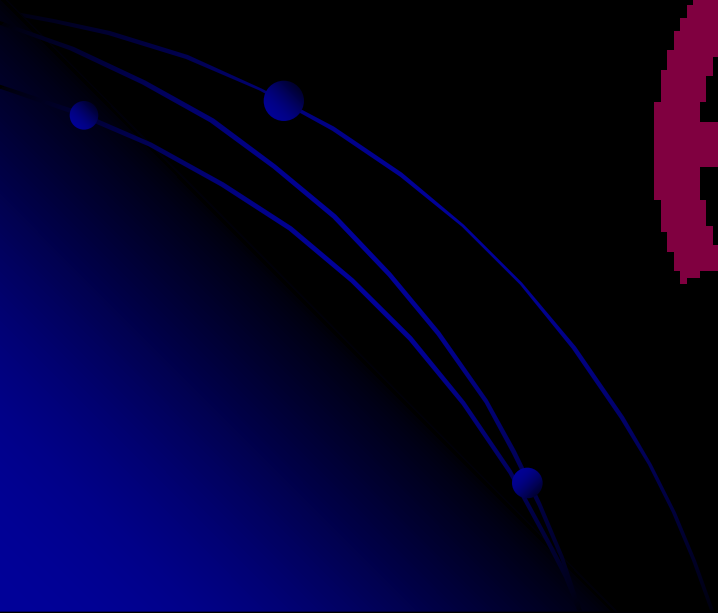


Galvanizing Oversized Pieces


09.19.2006


26th Street & the Dan Ryan

Standards & Inspection



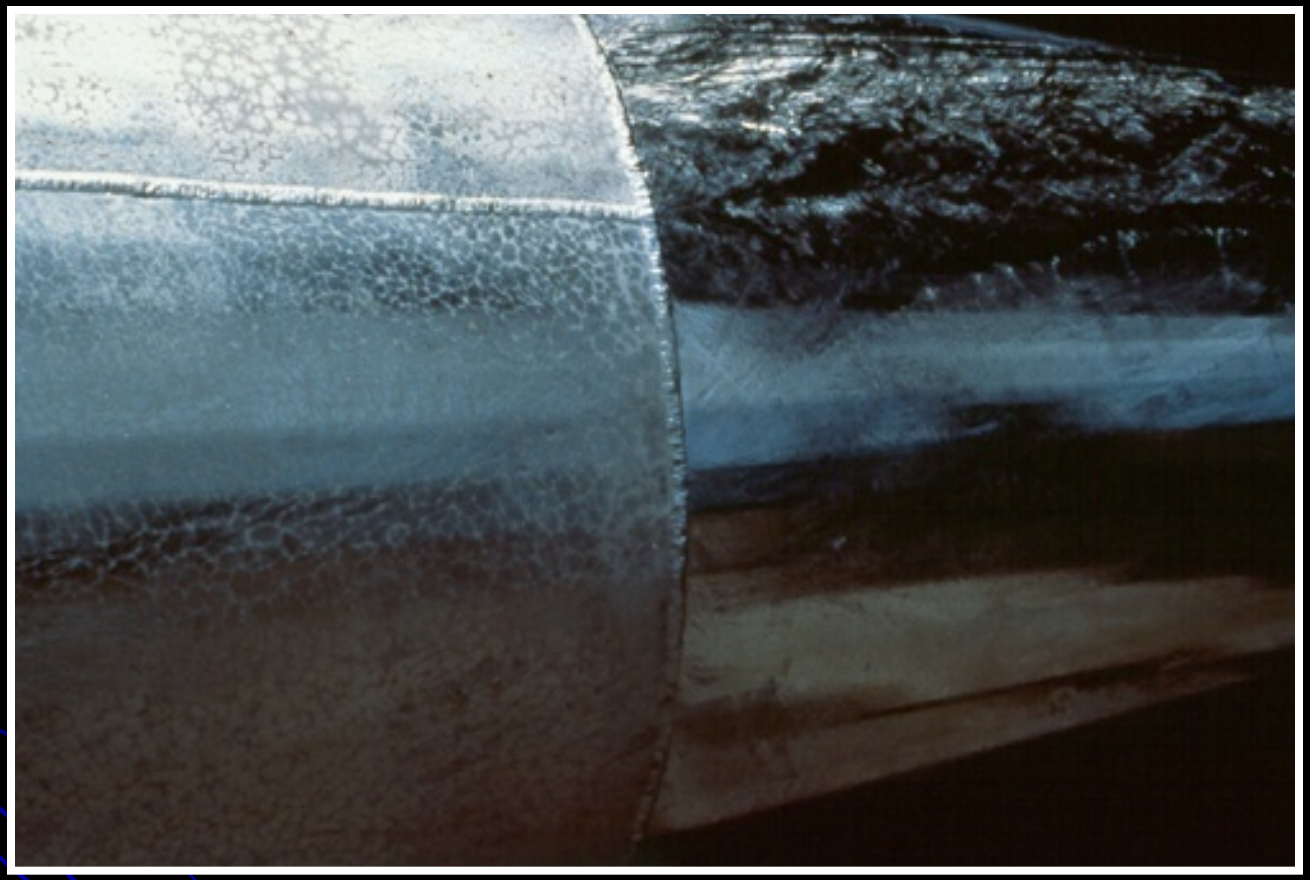
ASTM A 123

Coatings on Iron & Steel Products

ASTM A 153

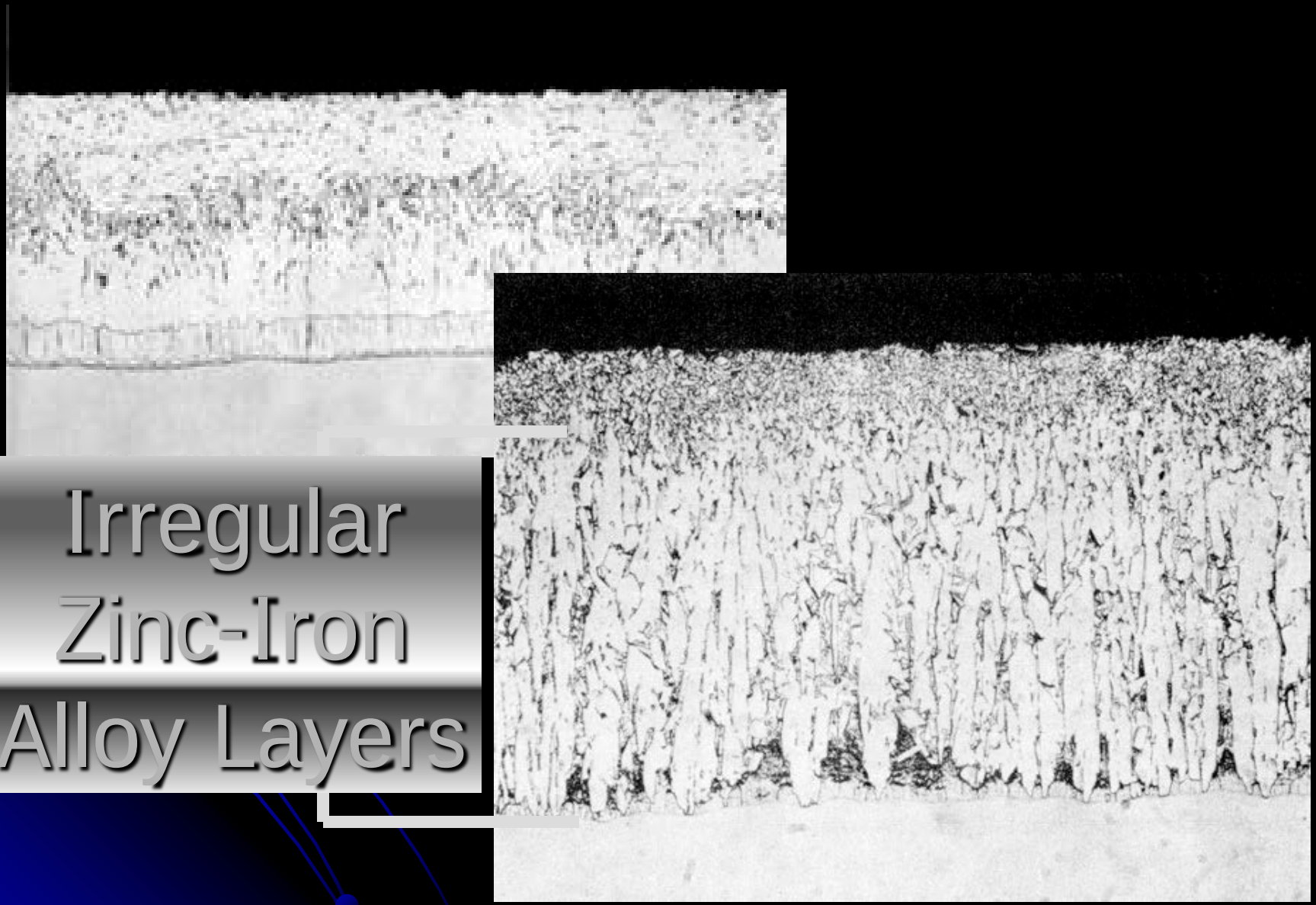
Coatings on Iron & Steel Hardware

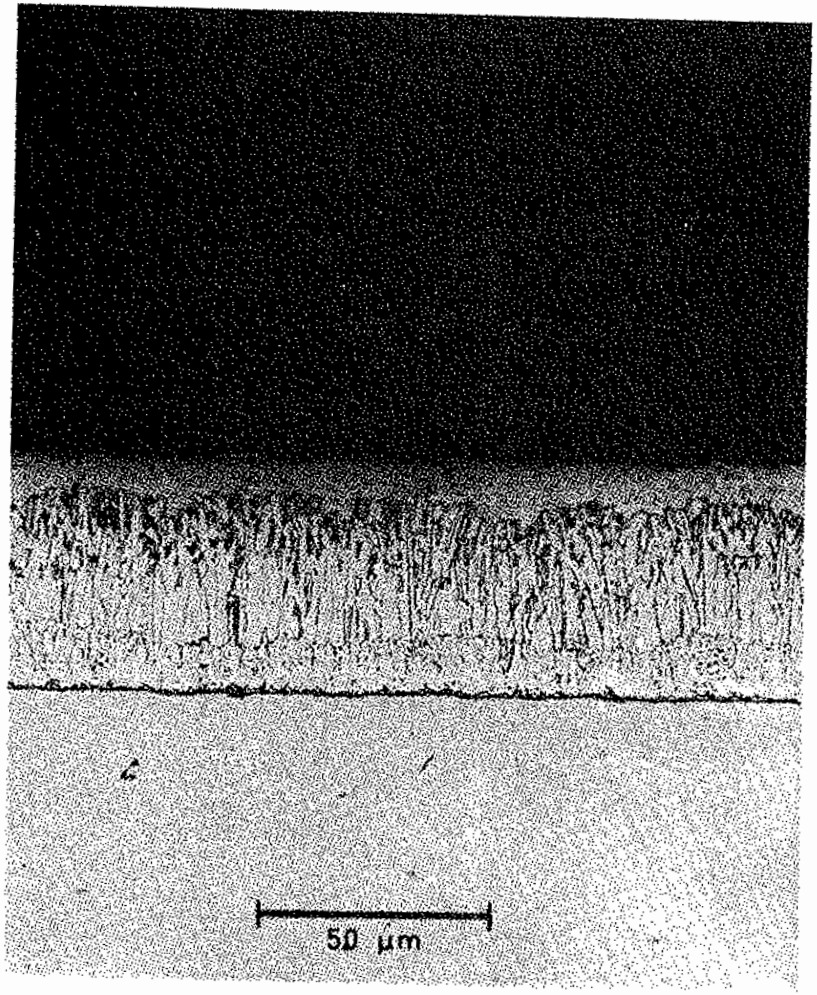
ASTM A 385



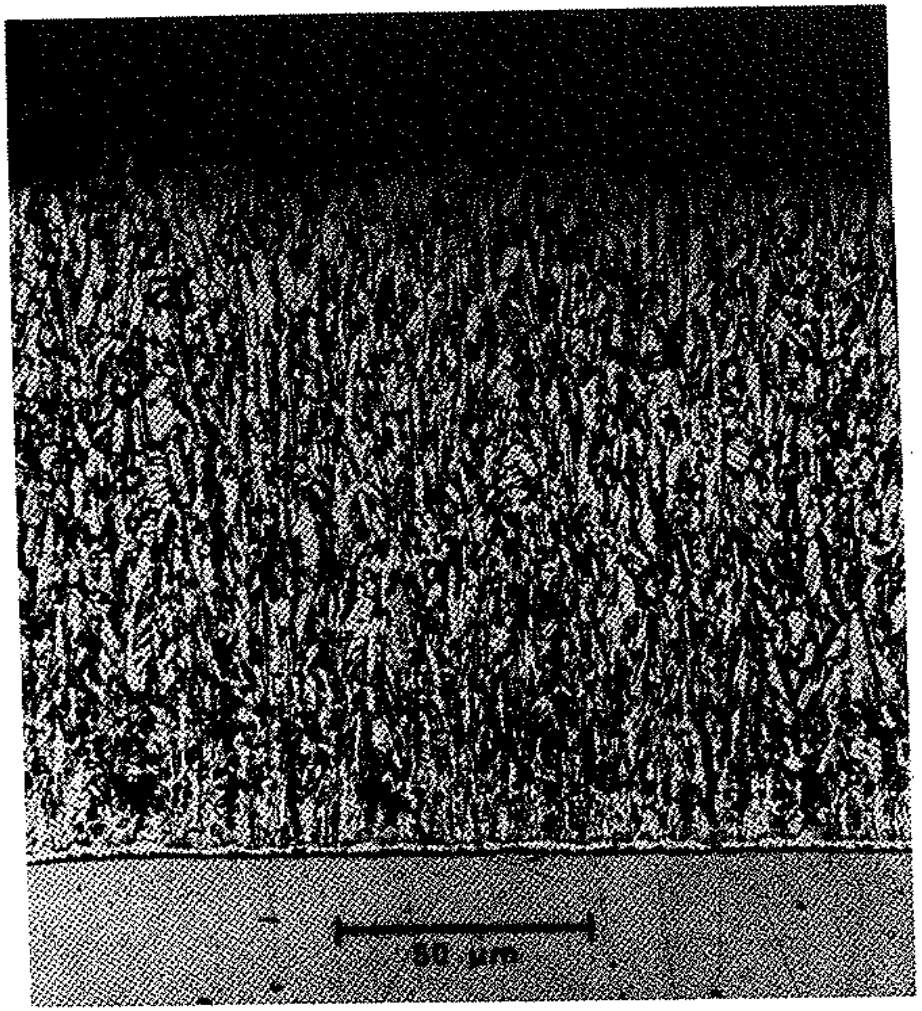
Providing High-Quality Zinc Coatings

Typical Zinc-Iron Alloy Layers

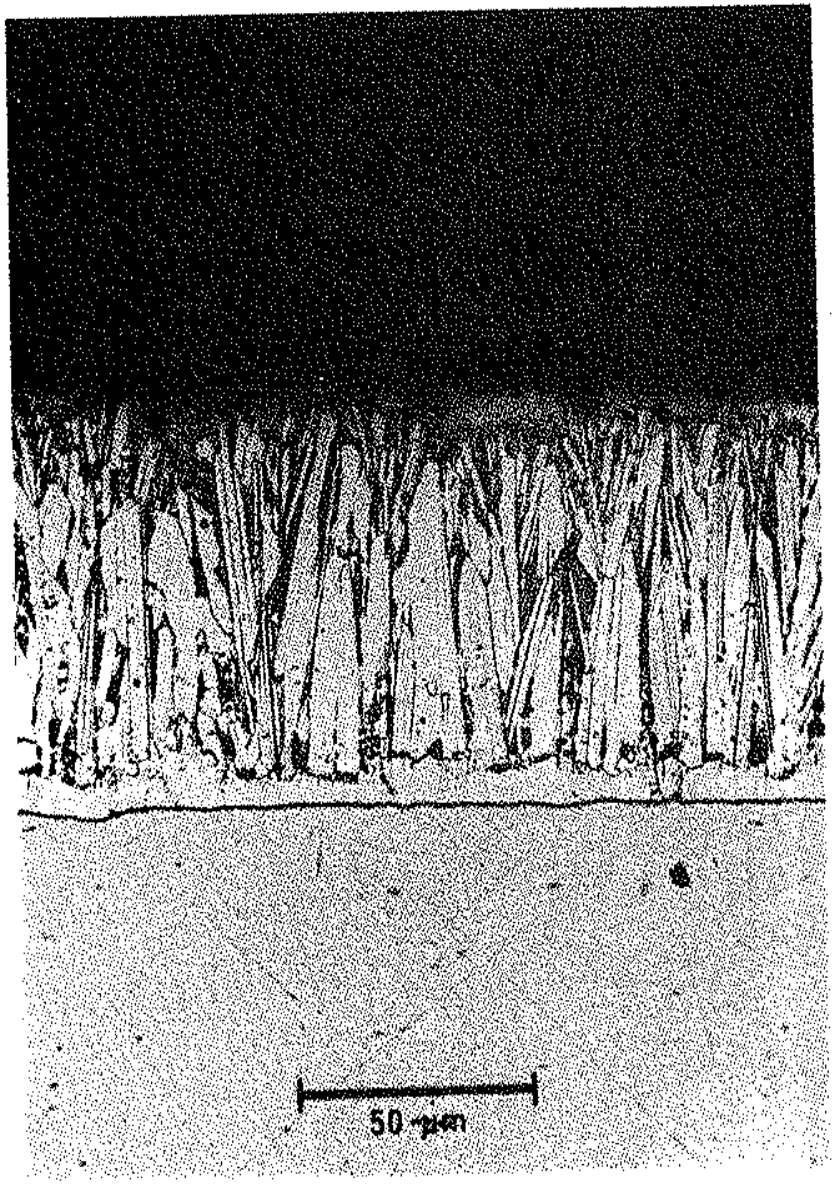




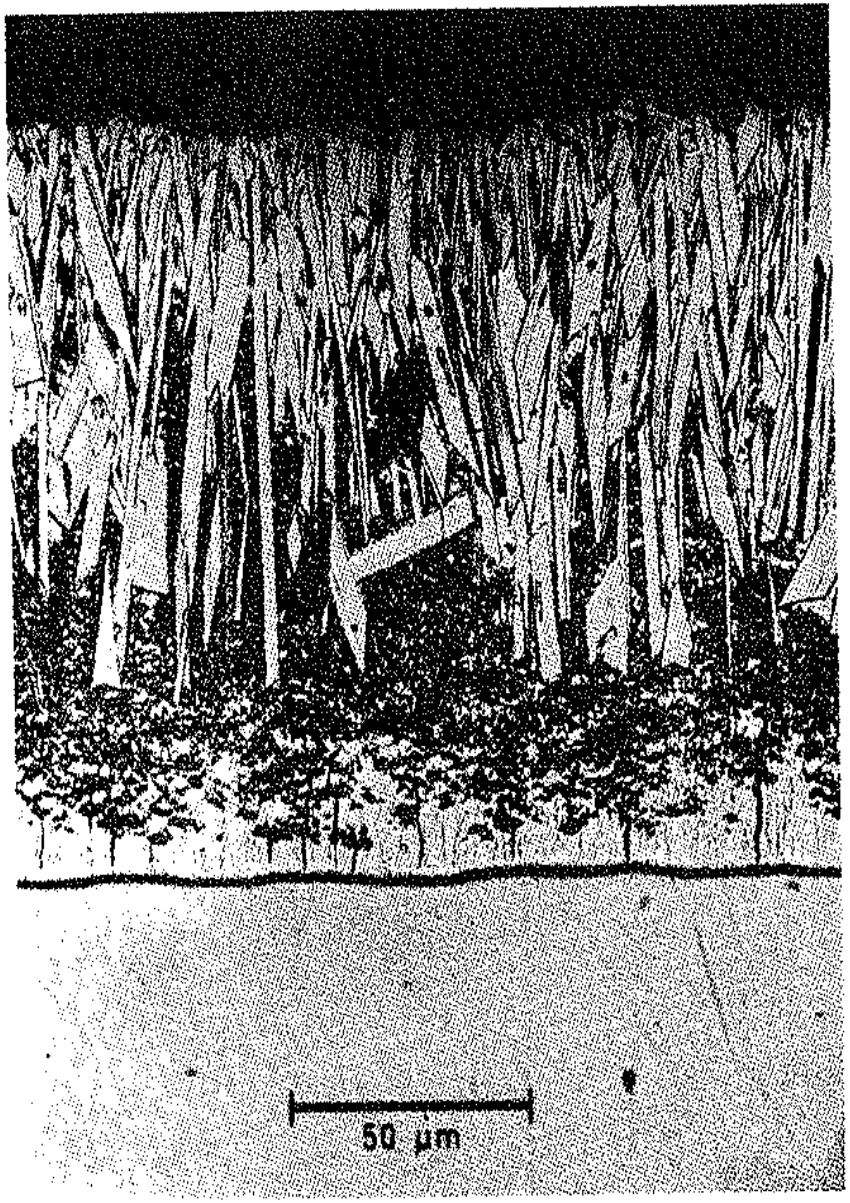
03% Si



10% Si



.24% Si

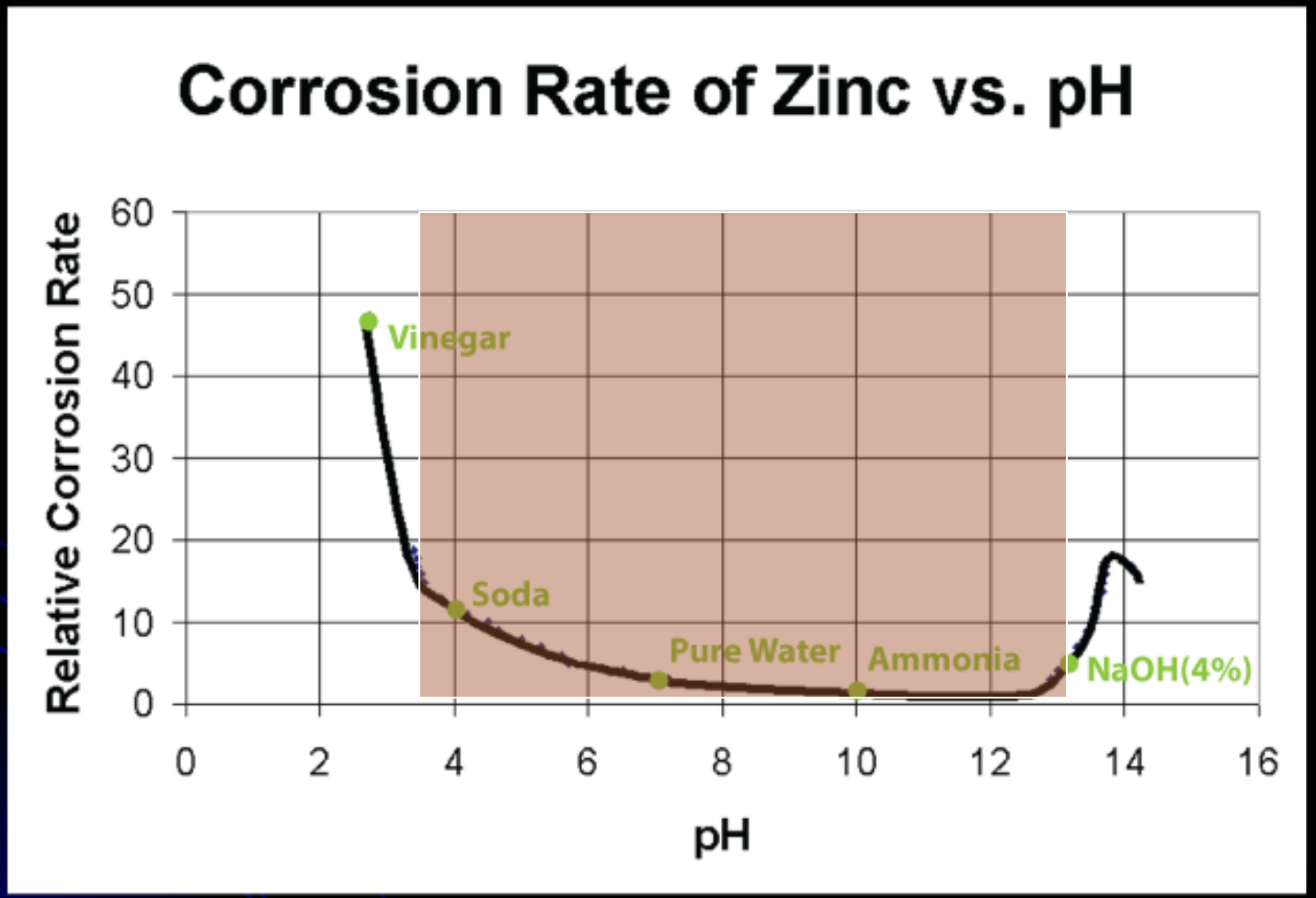


.44% Si

Steel Composition

Reactive Pipe

Electrochemical Corrosion Zone



Real-world Applications

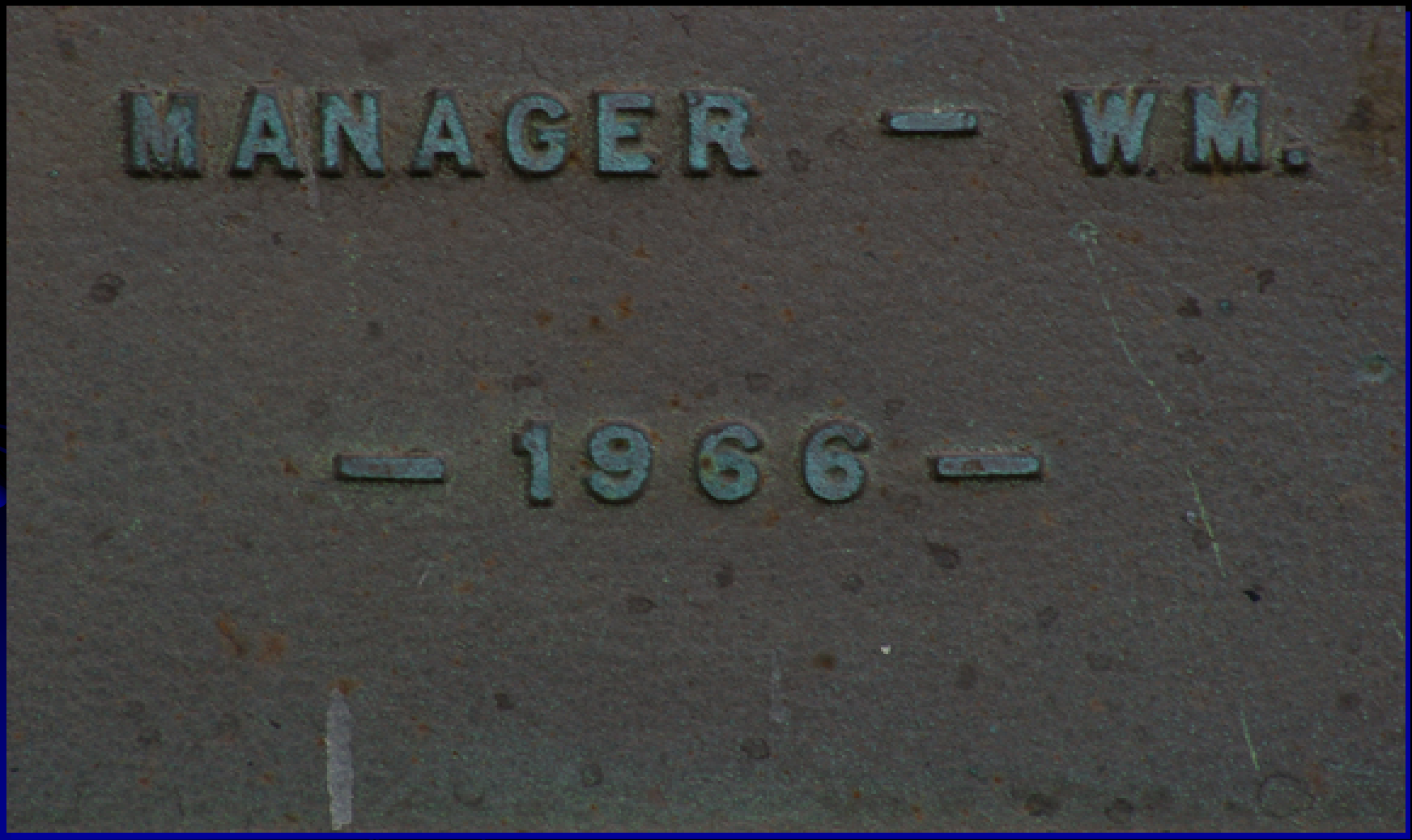
Stearns Bayou Bridge

- First fully galvanized bridge in the US
- Built in Michigan 1966
- All steel components were galvanized
  - handrail
  - diaphragms
  - fasteners
  - shear connectors
  - beams

The Sterns Bayou Bridge


Stears Bayou Bridge

Stearns Bayou Bridge




Stearns Bayou Bridge

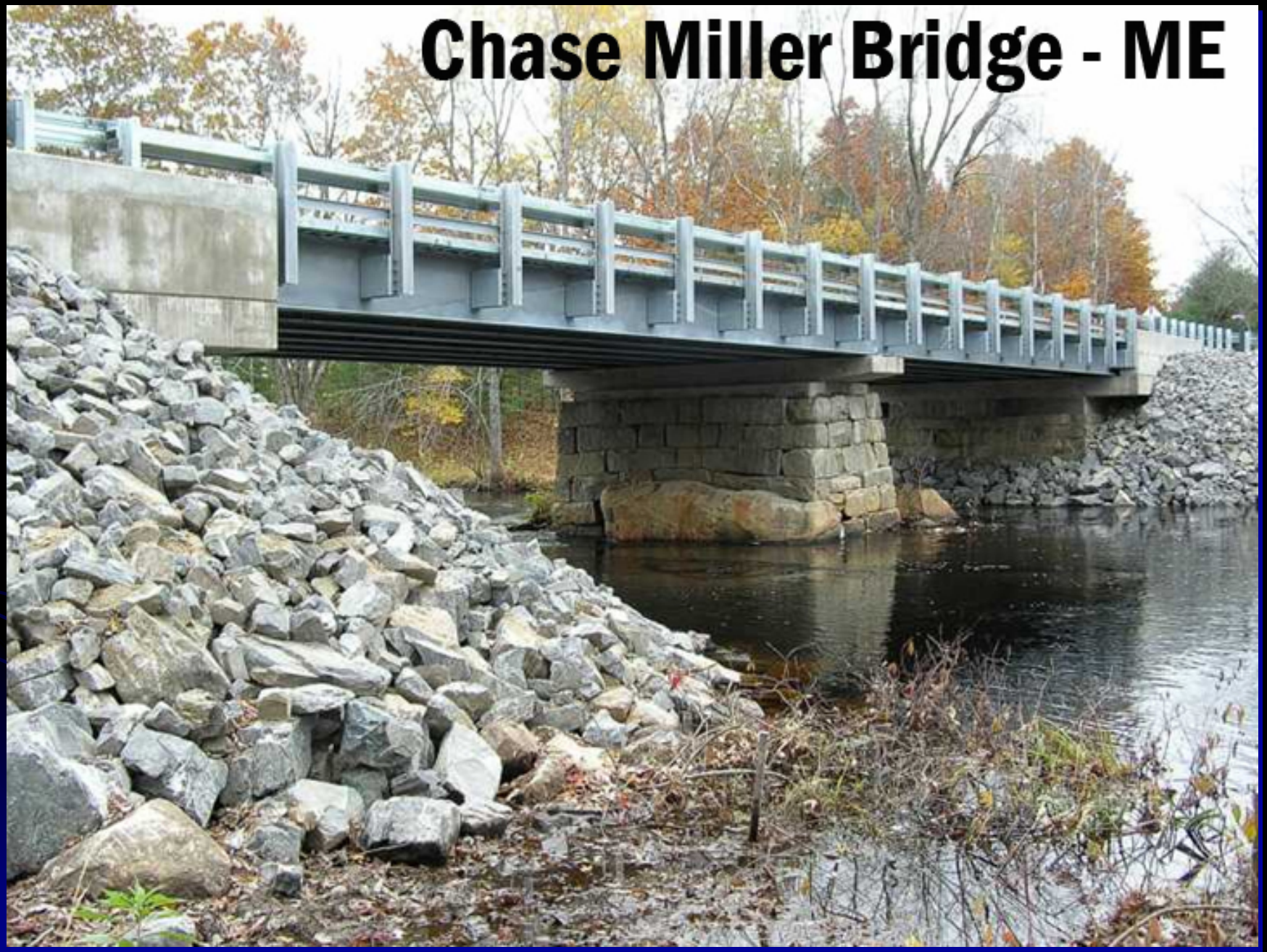
Sterns Bayou Bridge


F20H
Fischer
mils
2.94
Thickness
n= 96
DEL
ON/OFF

Sterns Bayou Bridge

Dick Vale Bridge Peru, ME


Montgomery County -Maryland


Chase Miller Bridge - ME


Fallowfield Township – Washington County PA

Bryants Bridge – Saratoga County N. Y.

Corrosion Protection

Questions ?

GalvanizeIt!

Thank You!

Kevin Irving
Central Marketing Manager
kevinirving@azzgalv.com
815-693-4242

AGA Member™
American Galvanizers Association
Protecting Steel for Generations
Zn

MUSKINGUM COUNTY ENGINEER'S OFFICE
ZANESVILLE, OHIO

BOGGS ROAD BRIDGE REPLACEMENT
STEEL VS. CONCRETE

Material Costs Steel:

1.	Bolt Together Steel Structure	$26,016
2.	Decking (1.5C – 18 ga. Decking	$2,223
3.	Shear Studs	$1,680
4.	Bridge Railing and Guard Rail	$14,590
5.	Reinforcing Steel	$7,490
6.	Concrete /Forms (180.5 CYs)	$27,026
7.	Asphalt Repair	$11,500
	Subtotal	$90,524

Labor and Equipment Costs:

1.	Labor (21 days)	$19,562
2.	Equipment	$21,679

Grand Total = $131,765

Material Costs Concrete:

1.	Concrete Box Beams (6 Beams)	$59,400
2.	Bridge Railing and Guard Rail	$11,500
3.	Reinforcing Steel	$5,000
4.	Concrete/Forms (160 CYs)	$24,000
5.	Asphalt Repair	$11,500
6.	Crane Rental	$2,500
	Subtotal	$113,900

Labor and Equipment Costs:

1.	Labor (18 days)	$14,757
2.	Equipment	$21,679

Grand Total = $150,336

Difference Between HDG Steel Beams and Concrete Box Beams ~ **$18,571**

ASTM A 780

Zinc-Based Alloys

Zinc Dust Paint

Metallizing

Repair of Damaged & Uncoated Areas of Hot-Dip Galvanized Coatings

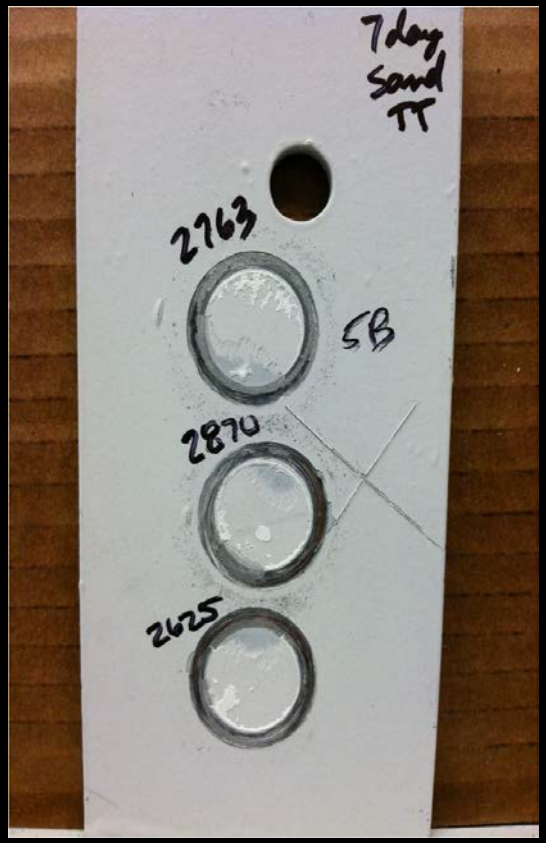
Painting Over Galvanized Steel

ASTM D 6386

Standard Practice for Preparation of Zinc (Hot-Dip) Galvanized Coated Iron & Steel Product & Hardware Surfaces for Painting

Stark County – Pro Football Hall of Fame Bridge

Adhesion of Coatings to Galvanizing



GalvanizeIt!

Thank You!

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Protecting Steel for Generations
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Hot-Dip Galvanizing Costs Less Lasts Longer

The Cost of Corrosion Protection

- Initial cost will always factor into decision
- Life-cycle cost analysis is more complete
  - Includes all future maintenance costs
  - Provides total cost of the project over its life
- Life-cycle cost calculation automated online at www.galvanizeit.org/galvanizingcost/

Quantitative Analysis

- Data Sources:
  - Paint – 2008 KTA Tator paper
    - Nationwide survey of the paint industry
    - Presented at NACE 2009
  - Galvanizing – 2008 AGA Industry Survey
- Project Parameters
  - Standard mix of steel (structural, tubing, plate)
  - 30,000 ft^2 project
  - Moderately industrial environment

Initial Cost Parameters

- Paint
  - Material (one- or two-pack product, number of coats, etc)
  - Shop cleaning labor
  - Shop/field application
  - Field labor
- Galvanizing
  - Process is inclusive of all cleaning, material, and labor

Initial Cost

Inorganic Zinc	$1.35	$40,410
Hot-Dip Galvanizing	$1.60	48,000
Inorganic Zinc/Epoxy	$2.16	$64,800
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$2.55	$76,620
Inorganic Zinc Primer/ Epoxy/ Polyurethane Topcoat	$3.17	$94,950

Life-Cycle Cost

- Maintenance costs calculated on a practical maintenance cycle (vs. ideal)
  - Unique to each paint system
  - Manufacturer recommended cycles provided in the KTA Tator paper
- NACE model for NFV and NPV calculations
  - 2% inflation; 4% interest
- 60-year life
- Maintenance repaint at 5% rust

Life-Cycle Cost ($/ft^2) 60-Year Life

Hot-Dip Galvanizing	$1.60
Inorganic Zinc	$5.16
Inorganic Zinc/Epoxy	$8.07
Inorganic Zinc Primer/Epoxy Intermediate/ Polyurethane Topcoat	$10.04
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$14.82

Total Cost of 60-Year Project

Hot-Dip Galvanizing	$48,000
Inorganic Zinc	$154,800
Inorganic Zinc/Epoxy	$242,100
Inorganic Zinc Primer/ Epoxy/ Polyurethane	$301,200
Acrylic WB Primer/ Acrylic WB Intermediate/ Acrylic WB Topcoat	$444,600

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