Steel Bridge Preservation
Galvanizing / Metallizing

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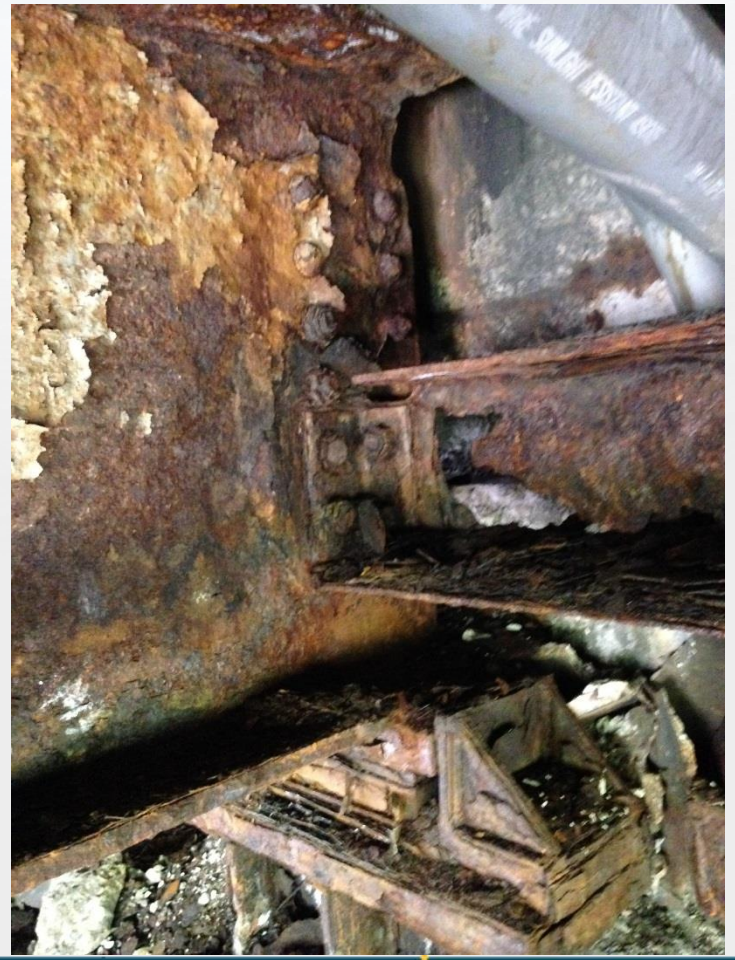
Steel Bridge Preservation
Galvanizing / Metallizing

- Why?
- How?
- The Illinois Experience.
- Issues.
- Cost?
- When?
- Questions?

Steel Bridge Preservation

Galvanizing / Metallizing – Why?



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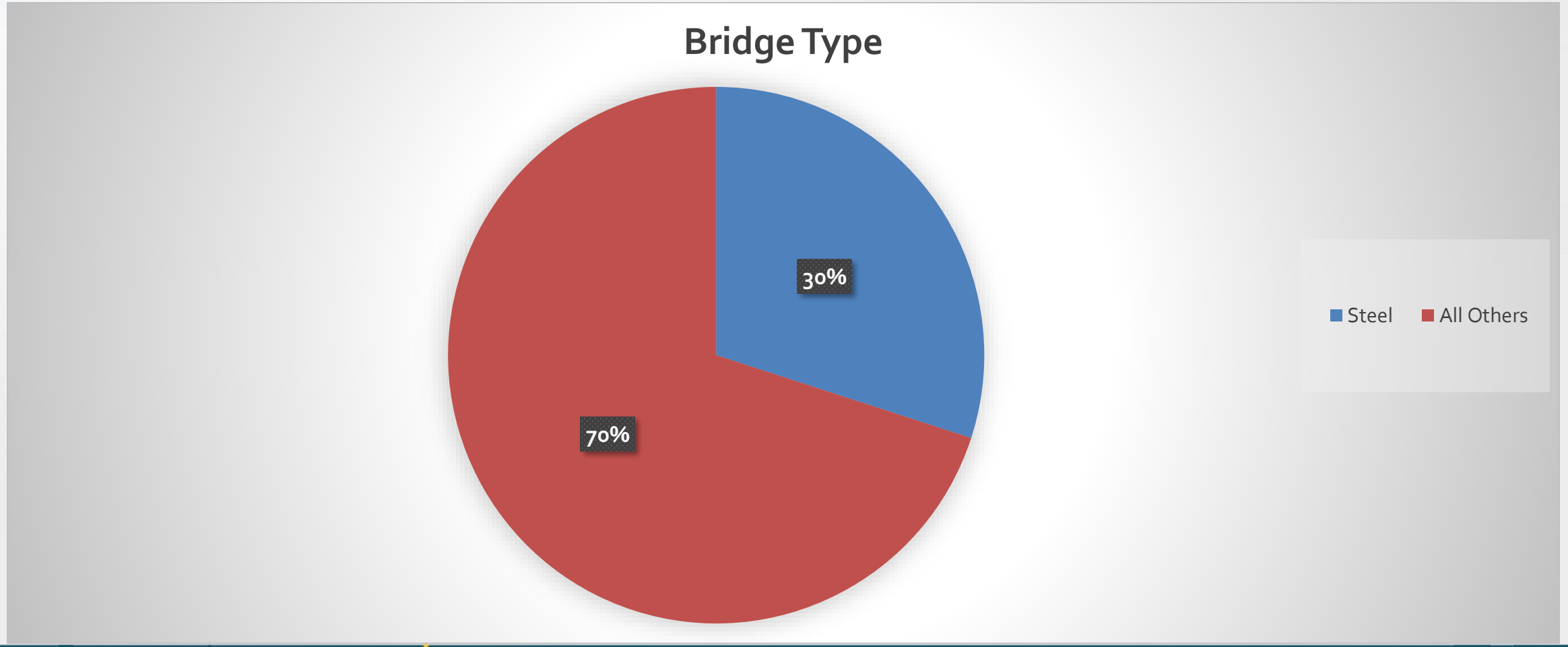
Galvanizing / Metallizing – Why?



Steel Bridge Preservation
Galvanizing / Metallizing – How?

Options –

- Standard painting – 2 or 3 coat systems.
- Weathering Steel
- Galvanizing / Metalizing
- Duplex Coatings -

Steel Bridge Preservation
Galvanizing / Metallizing – How / Paint?

Painting

- Lifecyle - depending on the environment, is finite.
- Costly to replace
  - $$
  - Lane Closures
  - Safety

Steel Bridge Preservation

Galvanizing / Metallizing – How / Paint?

Steel Bridge Preservation
Galvanizing / Metallizing – How / Weathering?

Weathering Steel –

- Still needs a protective coating at joints or locations of routine wetting.
- Shouldn't be used in humid climates.
- Can cause aesthetic issues at substructure units with rust staining

Hot-Dip Galvanizing

- Is NOT a paint coating.
- Is NOT zinc plating.
- Is NOT actually a Coating.

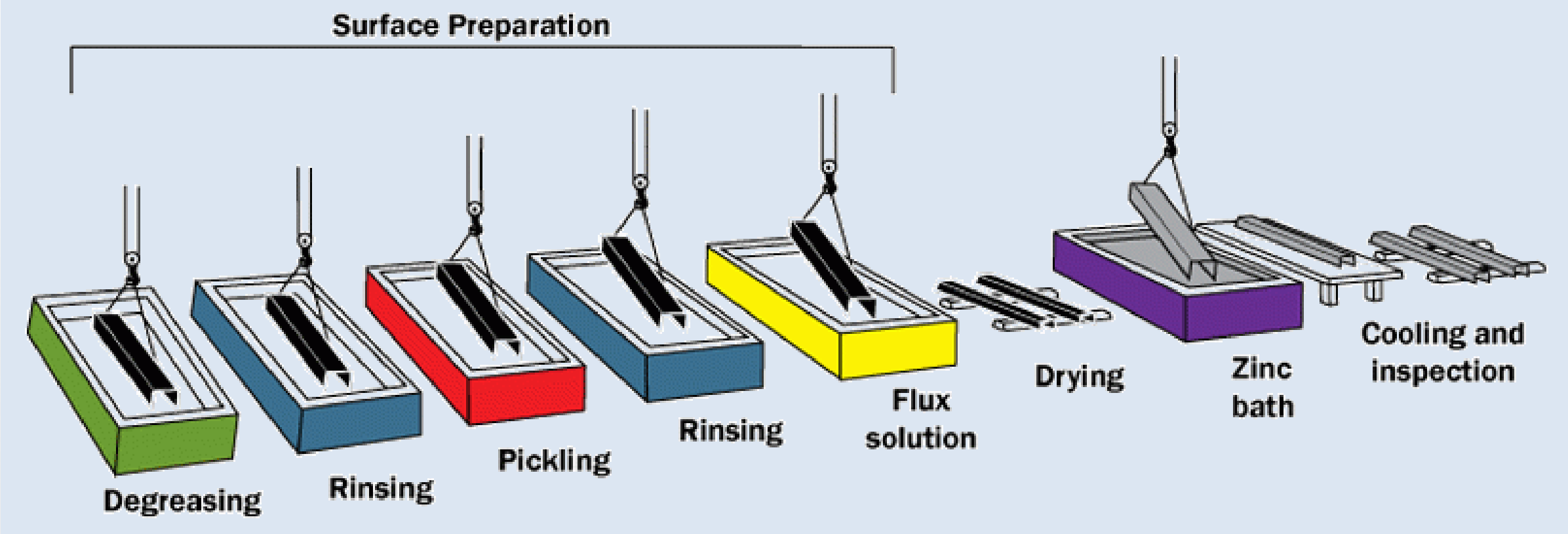
Steel Bridge Preservation

Galvanizing / Metallizing – How / Galvanizing?

- **Is a "Thermo-Chemical Diffusion Reaction"**
- **Between Molten Zinc and Clean Steel/Iron**

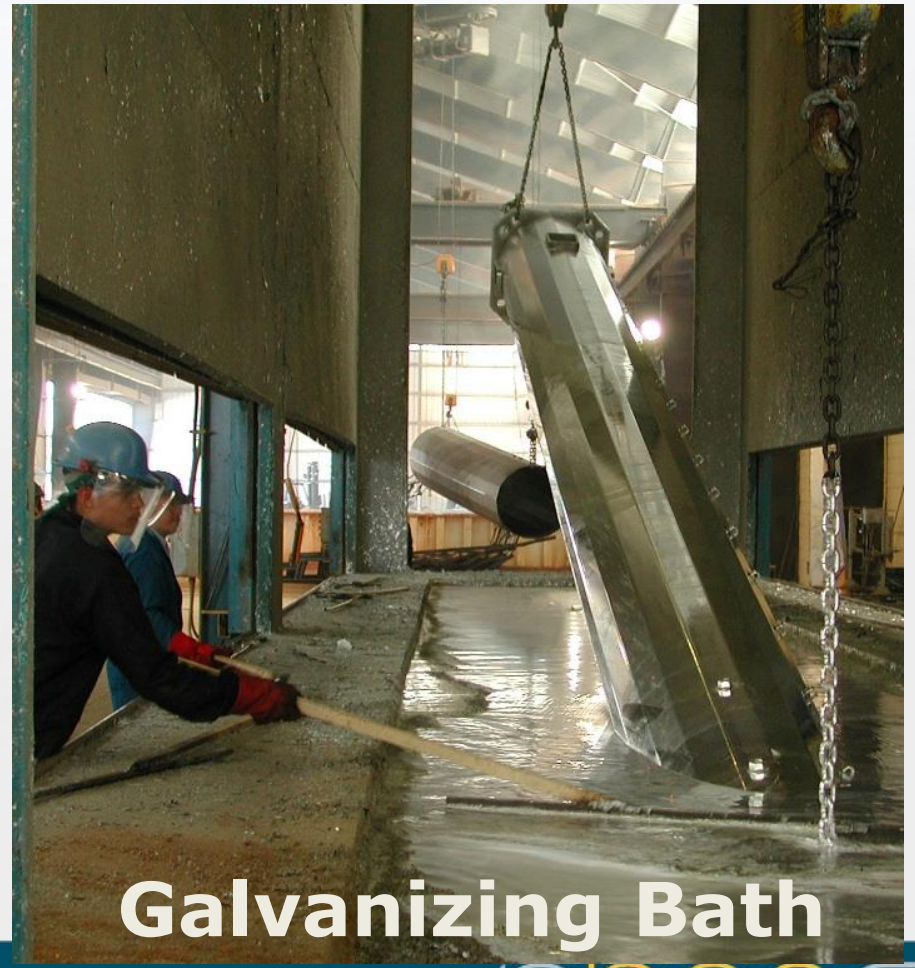
- **Which results in entirely new zinc/iron alloy layers in the surface of the steel substrate**

Hot-Dip Galvanizing Process



Galvanizing Plant

HDG Process: Galvanizing


Galvanizing Bath

- 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

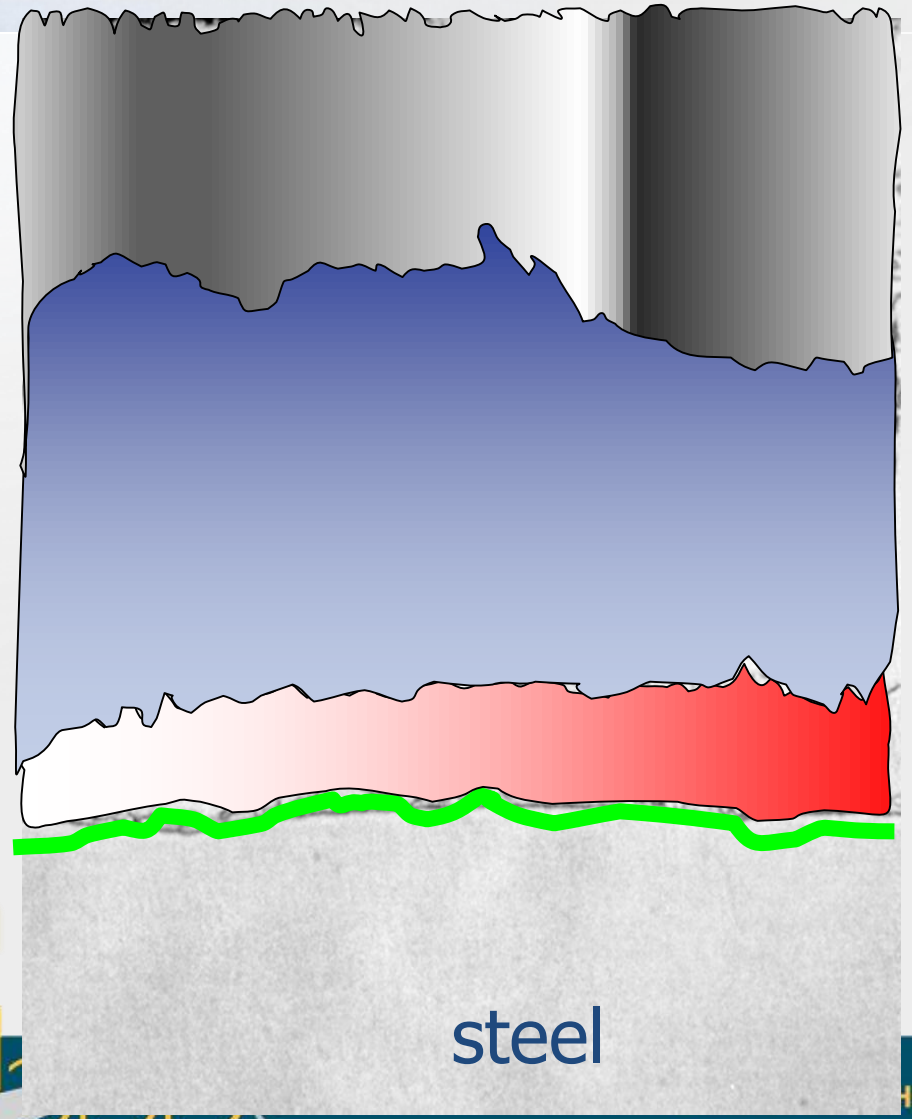
Metallurgical Bond

Eta

Zeta

Delta

Gamma



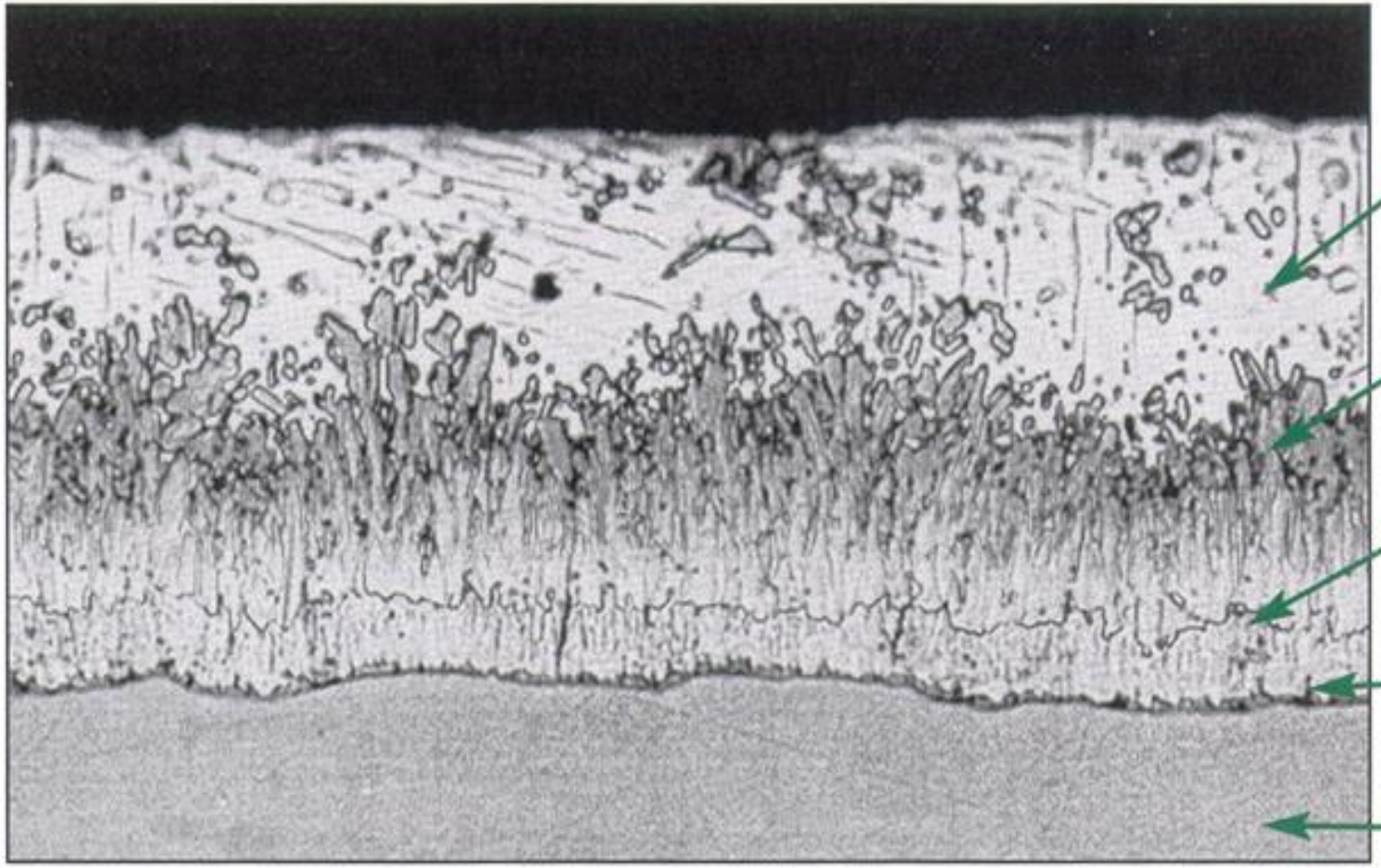
100% Zinc

94% Zinc 6% Iron

90% Zinc 10% Iron

75% Zinc 25% Iron

Hardness of HDG Steel



Eta
(100% Zn)
70 DPN Hardness

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

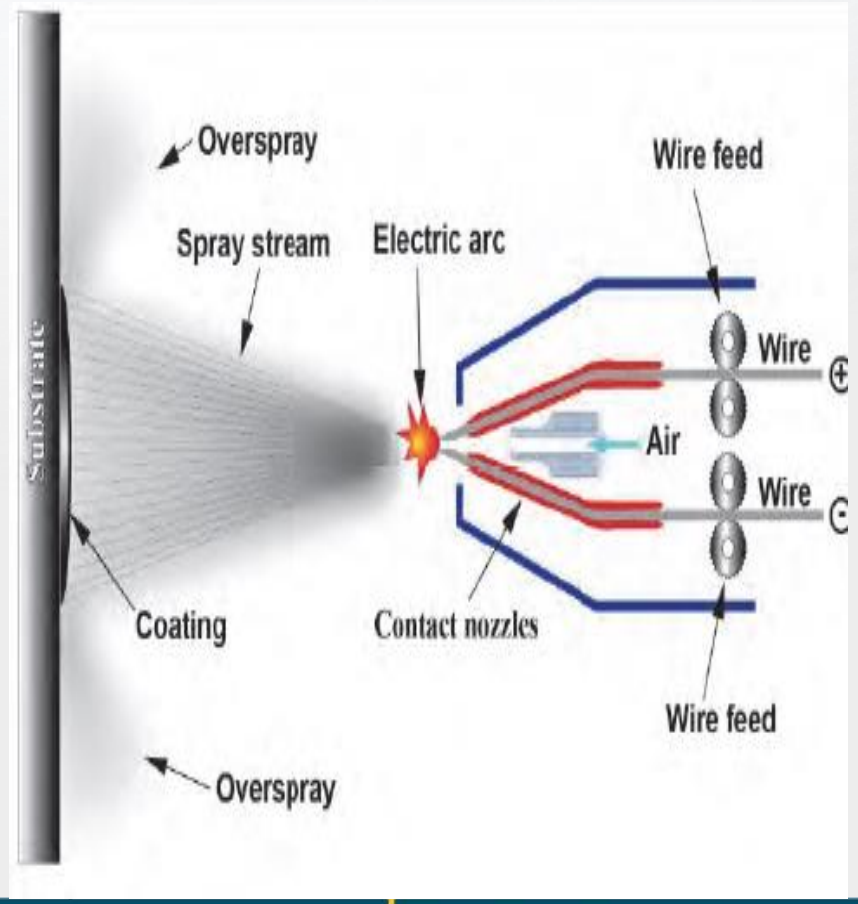
Delta
(90% Zn 10% Fe)
244 DPN Hardness

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

Base Steel
159 DPN Hardness

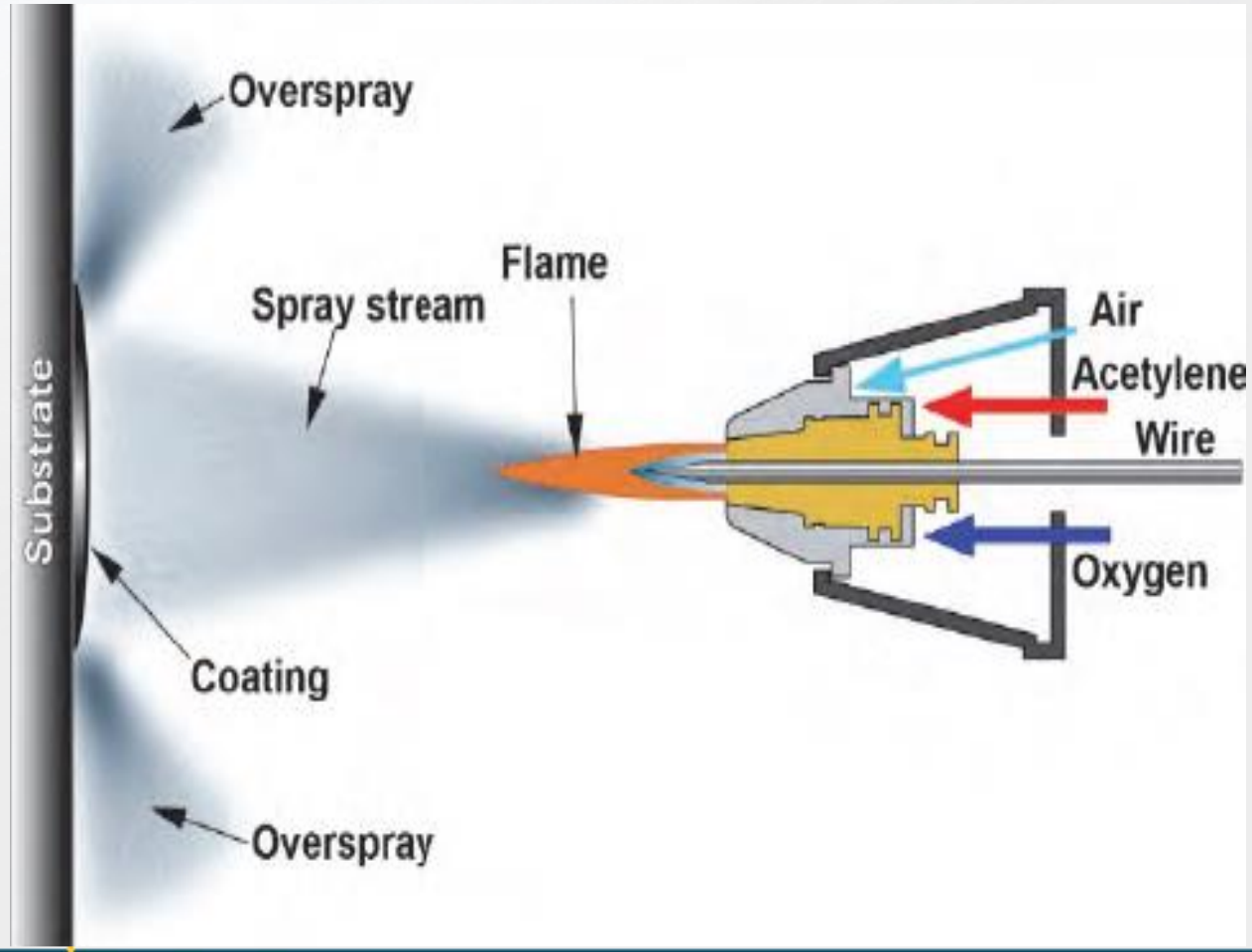
Metalizing or Thermal Spray

Twin- Wire Arc Spray



Metalizing or Thermal Spray

Flame Spray



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Galvanizing / Metallizing – How / Duplex Coatings?

Coatings of the future are combining Galvanizing and paint or powder coatings to extend life cycles even further.

This can be done with proper preparation of the Galvanized surface, and research shows that it can extend the life of galvanized surface beyond an uncoated surface.

Steel Bridge Preservation
Galvanizing / Metallizing - Illinois

Challenges with steel preservation in Illinois:

- Climate, climate, climate
- System age –bridges built in 1950s/1960s
- Insufficient maintenance budget
- Lead Painted Steel = high cost of repainting
- Urban high volume roads = limited painting windows
- Unique challenge of an electrified light rail system under many bridges.

Steel Bridge Preservation
Galvanizing / Metallizing - Illinois

Needing a method to protect the steel in the urban area on a longer term basis than painting – IDOT turned first to galvanizing the new rolled sections, and later to metallizing larger plate girders when galvanizing wasn't feasible.

First used in 2002, inspections show little change in some 15 years of the aggressive Illinois environment.

Steel Bridge Preservation
Galvanizing / Metallizing - Illinois

Since 2002, IDOT has re-built over 30 bridges using galvanized or metallized steel with no significant issues.

Certainly when looking at the challenges that Illinois has in the metropolitan areas – the advantages of galvanizing and metallizing to reduce future maintenance needs is readily apparent.

Steel Bridge Preservation
Galvanizing / Metallizing - Illinois

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Galvanizing/Metallizing I-55 at Lake Shore Dr

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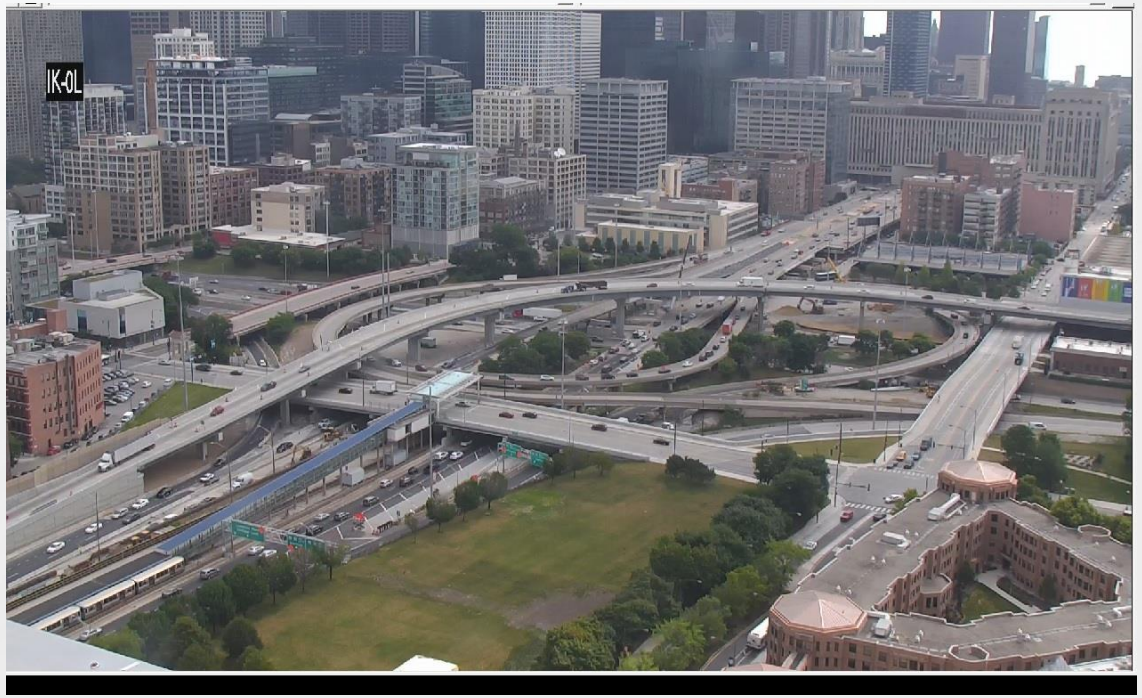
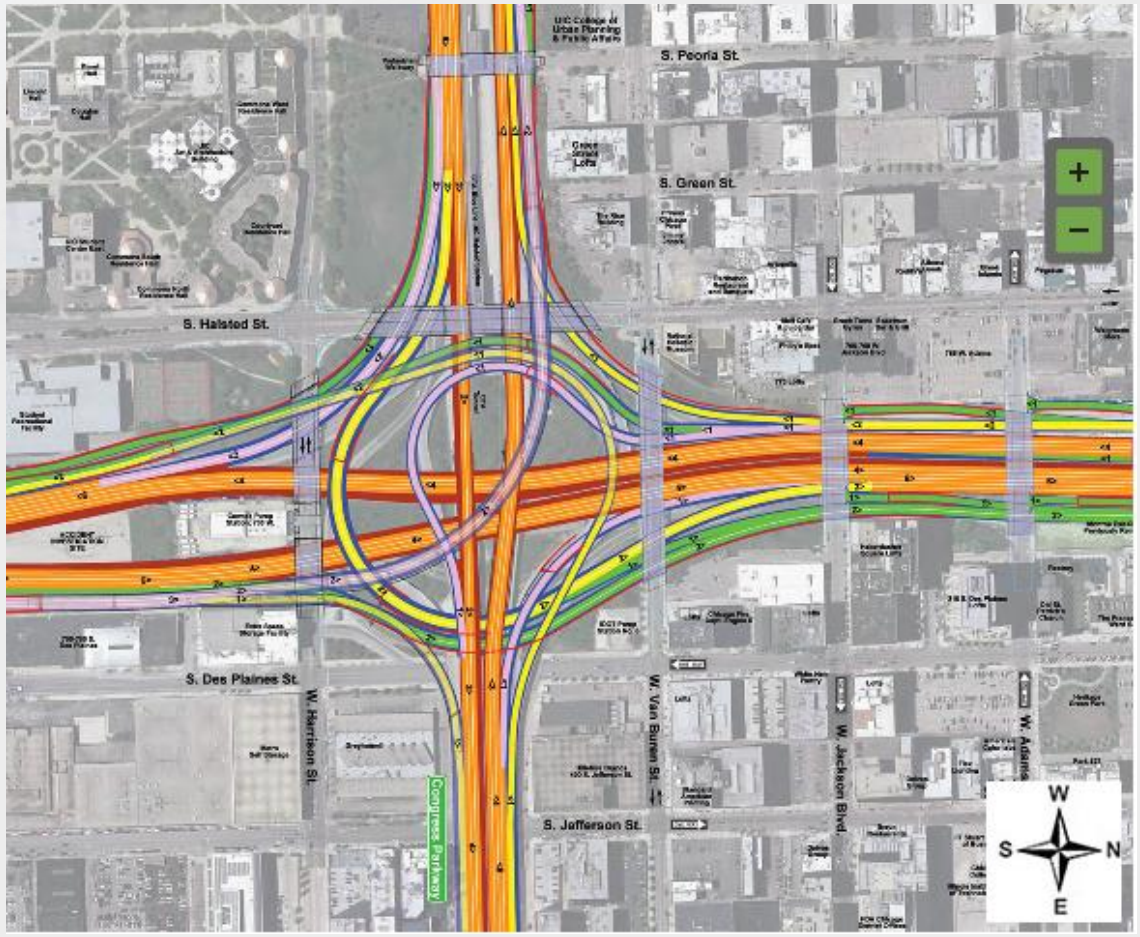
Galvanizing / Metallizing – Chicago's Circle Inter.





Steel Bridge Preservation
Galvanizing / Metallizing - Issues

Design Issues:

- Limited Tank Size may require additional Splices.
- Plate Girders may require additional stiffeners

Construction Issues:

- To get longer beams dipped, may require dipping at an angle which leaves lines
- Blotchy initial appearance of metallizing surfaces.

Steel Bridge Preservation
Galvanizing/Metalizing - Costs

Hot-Dip Galvanizing
Costs Less Lasts Longer

Economic Advantages

- Initial cost benefits
  - Overall material cost, as well as time savings

- **Life-cycle cost savings**
  - Total cost of project throughout its life
    - Includes maintenance costs and time value of money
    - HDG often initial cost IS life-cycle cost

Cost Case Study

- Data Sources:
  - Paint – 2014 **KTA Tator paper** (newest published)
    - Nationwide survey of the paint industry
    - Presented at NACE 2014
  - Galvanizing – 2014 AGA Industry Survey
    - Using US average
    - Can input customized cost
  - Project Parameters:
  - Typical mix of size/shapes
  - 50,000 ft² project
  - 75 year design life
  - Moderately industrial environment (C3)

Initial Cost Parameters

- Other systems
  - Material (one- or two- pack product, number of coats, etc.)
  - Surface Preparation/ Cleaning Methods
  - Shop/field application
  - Shop/field labor
- Galvanizing
  - Process is inclusive of all cleaning, material, and labor

Initial Cost

Coating System	$/ft^2	Total
Hot-Dip Galvanizing	$1.76	$88,000
Epoxy/Epoxy	$2.82	$141,200
Epoxy/Polyurethane	$2.61	$130,600
Inorganic Zinc/Epoxy	$2.85	$142,700
Inorganic Zinc/Epoxy/Polyurethane	$4.17	$208,500
Galvanizing/Epoxy/Polyurethane	$5.22	$260,750
Metallizing	$8.13	$406,450

Life-Cycle Cost Parameters

- Maintenance costs
  - Calculated on practical cycle (vs. ideal)
  - Unique to each system
  - Based on manufacturer recommendation in **KTA Tator paper**
- NACE model for NFV and NPV Calculations
  - 3% inflation, 2% interest
- Project Parameters:
  - Typical mix of size/shapes
  - 50,000 ft² project
  - 75 year design life
  - Moderately industrial environment (C3)

Total Life-Cycle Cost (75 Years)

Coating System	$/ft^2	Total
Hot-Dip Galvanizing	**$1.76**	$88,000
Galvanizing/Epoxy/Polyurethane	**$22.45**	$1,122,500
Inorganic Zinc/Epoxy	**$35.91**	$1,795,500
Inorganic Zinc/Epoxy/Polyurethane	**$38.26**	$1,913,000
Epoxy/Epoxy	**$38.31**	$1,915,500
Epoxy/Polyurethane	**$51.90**	$2,595,000
Metallizing	**$60.99**	$3,049,500

Steel Bridge Preservation
Galvanizing / Metallizing – When?

During the preliminary phase of any bridge design, consideration should be given to the future maintenance challenges and the life cycle costs of steel preservation.

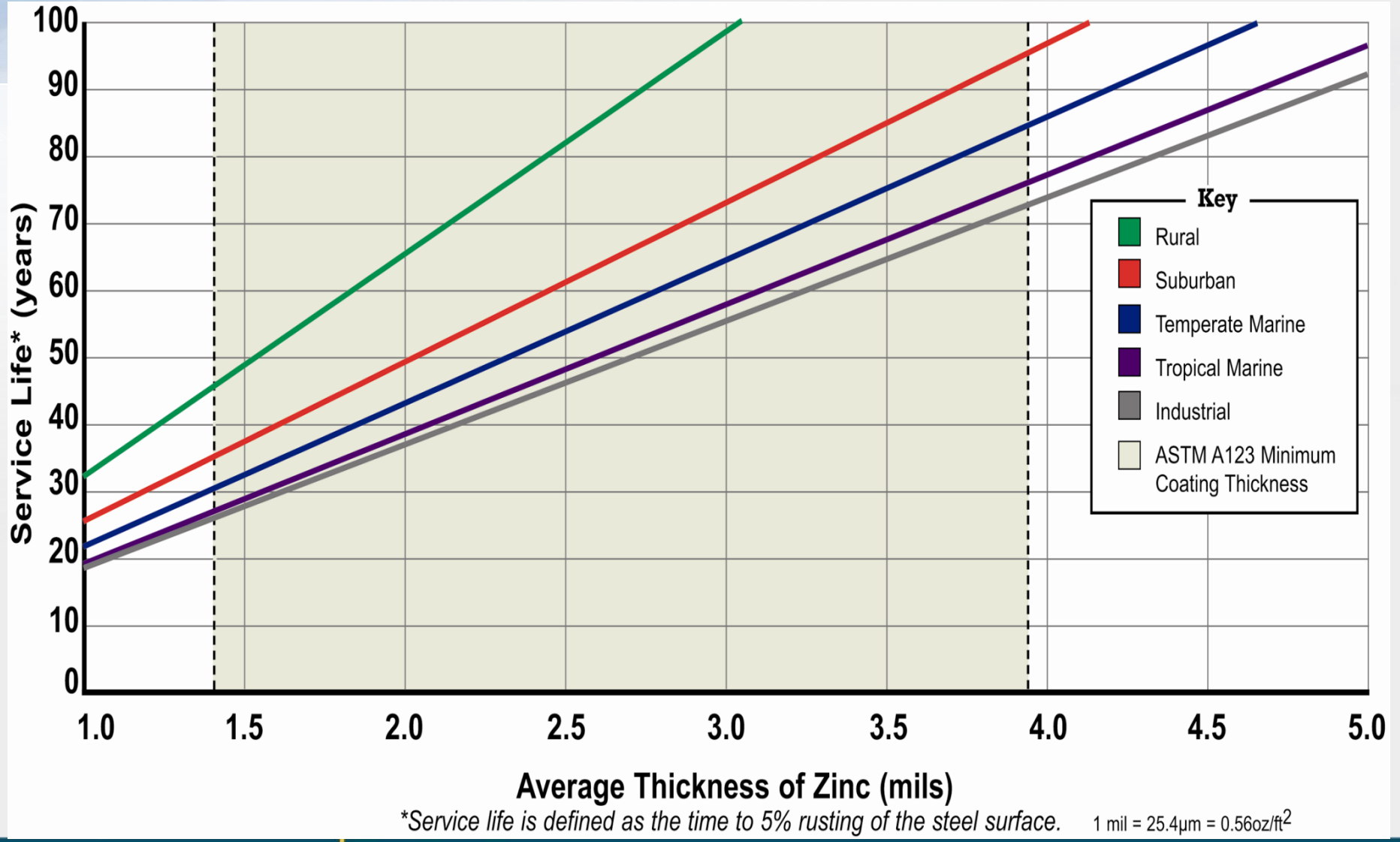
Galvanizing / Metallizing offers identifiable benefits with minimal up-front costs if the bridges will exist in an environment conducive to steel corrosion.

Bryanys Bridge – Saratoga County N. Y.

Ford County – 00N, 2350E in Illinois


5.5 mils
Average after
48 plus years!

Estimated Service Life of HDG



Stearns Bayou Bridge in Grand Haven, MI

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

Stearns Bayou Bridge

Stearns Bayou Bridge


PosiTector®
D
N
Cal 1
0.0
Zn
2.4
thou/mils

Corrosion Protection 1970

Questions ?

Steel Bridge Preservation
Galvanizing / Metallizing – Questions?

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