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AZ AZZ

Tonight's Topics

- Hot Dip Galvanizing Process
- ASTM A123 – Mils
- Layers of Zinc
- Coating Appearance
- Duplex Coating

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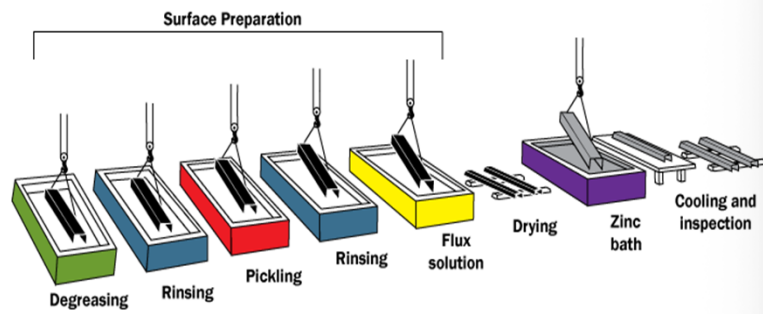
This slide features a dark blue header with the AZZ logo in the top right. Below the header, the title 'Tonight's Topics' is in white. To the left of a photograph is a list of five topics, each preceded by a bullet point. The photograph on the right shows the interior of a large industrial galvanizing plant. It depicts a long, narrow processing line with various tanks and machinery. A large plume of white steam or smoke rises from the right side of the line. Several workers in safety gear are visible on the floor of the plant. The floor is concrete and has some yellow markings. The overall scene is industrial and brightly lit.

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Hot-Dip Galvanizing Multi Step Process

- Receiving and Inspection
- Rack-up
- Caustic Cleaning
- Pickling
- Flux
- Zinc Bath (Kettle)
- Clean Up
- Inspection and Shipping



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HDG Process: Rack-up

Rack-up

- Locate lifting points
- Any additional holes required?
- Is material free from zinc/paint/oils?



Rack-up Area

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HDG Process: Surface Preparation

Caustic Cleaning

- **Degreasing** – removes dirt, oils, organic residue
- 8 – 12% Sodium Hydroxide
- Same strength as laundry detergent



Caustic Tank

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HDG Process: Surface Preparation

Acid Pickling

- **Pickling** – Removes mill scale and oxides
- 6 – 12% Hydrochloric Acid
- Exposes bare metal to react to zinc bath



Pickling Tank

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HDG Process: Surface Preparation

Fluxing

- **Fluxing** – Mild cleaning, provides protective layer
- 24% Zinc Ammonium Chloride
- Removes any remaining oxides and prevents oxides prior to galvanizing

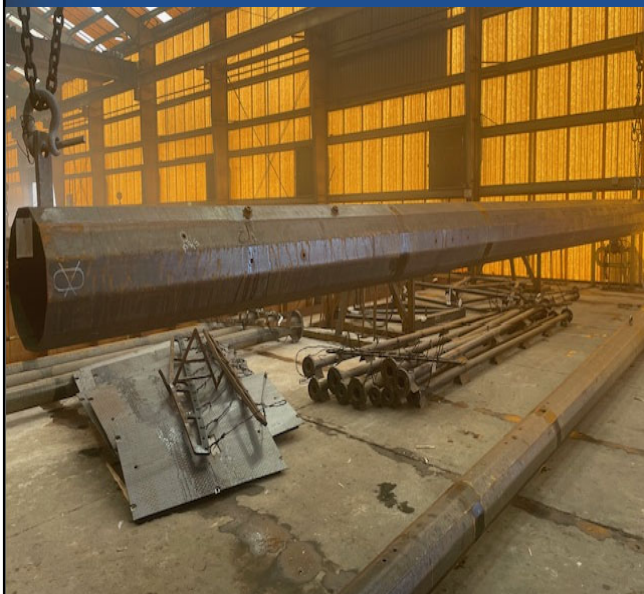


Flux Tank

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HDG Process: Before & After



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HDG Process: Galvanizing

Kettle

- Steel immersed in bath of molten zinc (~830 F)
- > 98% pure zinc
- Zinc metallurgically reacts with iron in steel to form coating, 3,600PSI.
- Reaction is complete when steel reaches bath temperature



Kettle

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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

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ASTM A123 – Minimum Average Thickness

TABLE 1 Minimum Average Coating Thickness Grade by Material Category

Material Category	All Specimens Tested Steel Thickness Range (Measured), in. [mm]					
	<1/16 [<1.6]	1/16 to <1/8 [1.6 to <3.2]	1/8 to 3/16 [3.2 to 4.8]	>3/16 to <1/4 [>4.8 to <6.4]	≥1/4 to <3/8 [≥6.4 to <16.0]	>3/8 [>16.0]
Structural Shapes	45	65	75	75	100	100
Strip and Bar	45	65	75	75	75	100
Plate	45	65	75	75	75	100
Pipe and Tubing	45	45	75	75	75	75
Wire	35	50	60	65	80	80
Reinforcing Bar	100	100

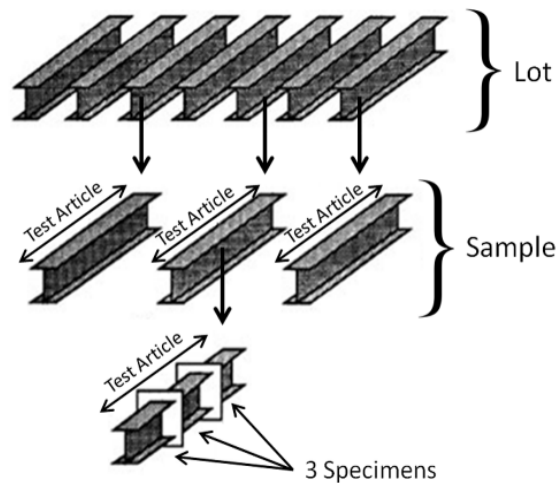
TABLE 2 Coating Thickness Grade^A

Coating Grade	mils	oz/ft ²	μm	g/m ²
35	1.4	0.8	35	245
45	1.8	1.0	45	320
50	2.0	1.2	50	355
55	2.2	1.3	55	390
60	2.4	1.4	60	425
65	2.6	1.5	65	460
75	3.0	1.7	75	530
80	3.1	1.9	80	565
85	3.3	2.0	85	600
100	3.9	2.3	100	705

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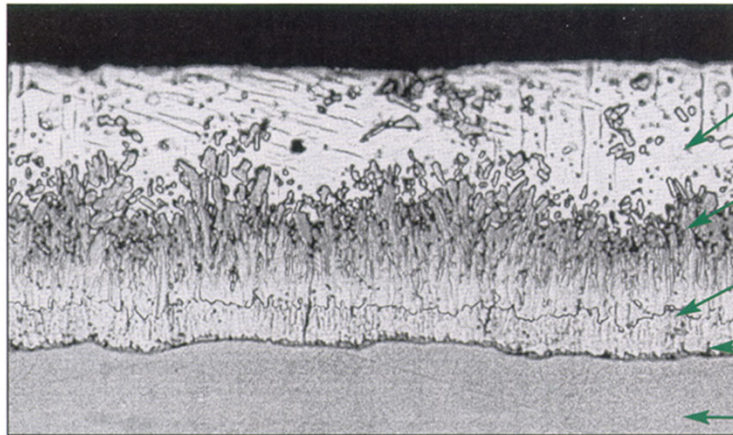
ASTM A123 – Minimum Average Thickness



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Metallurgical Bond – DPN (Diamond Pyramid Number)



Eta
(100% Zn)
70 DPN Hardness

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

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

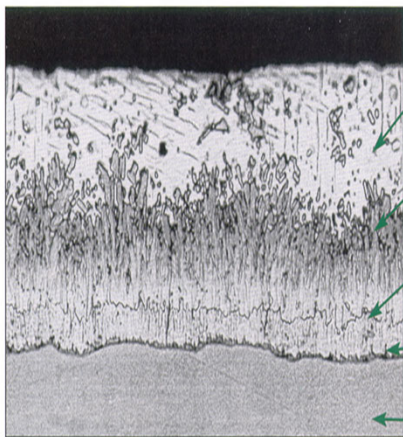
Gamma
(75% Zn 25% Fe)
250 DPN Hardness

Base Steel
159 DPN Hardness

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Metallurgical Bond – Top Layer Removed



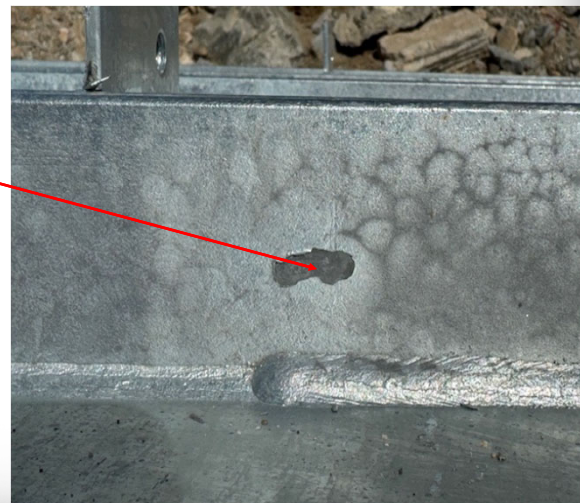
Eta
(100% Zn)
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Zeta
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179 DPN Hardness

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

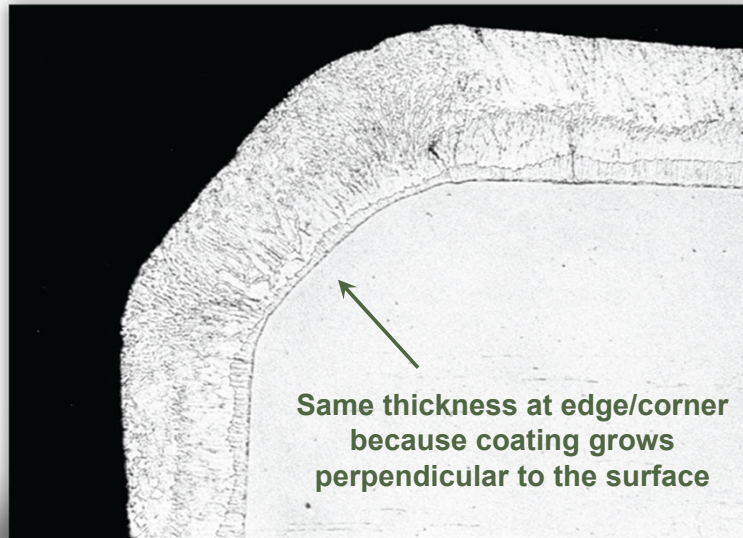
Gamma
(75% Zn 25% Fe)
250 DPN Hardness

Base Steel
159 DPN Hardness



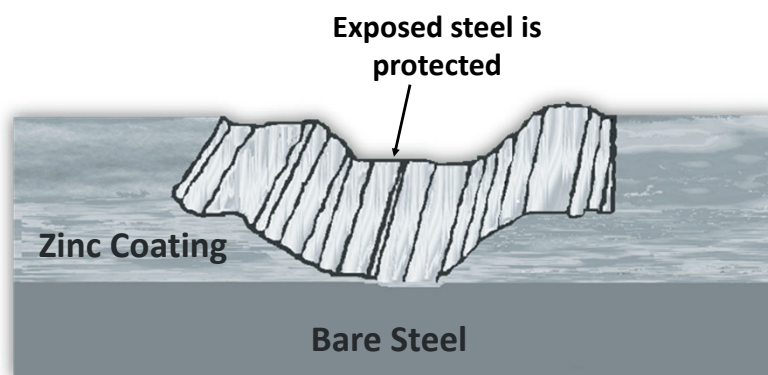
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Edge Protection



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Cathodic Protection: Sacrificial Zinc



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

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Coating Appearance: Newly Galvanized

Shiny



Matte Gray




Spangled



Shiny & Dull



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Finish of Galvanizing – Acceptable

Oxide Lines

Oxide lines are light colored film lines on the galvanized steel surface created when a product is not removed from the galvanizing kettle at a constant rate.

Oxide lines are strictly an aesthetic condition, having no effect on corrosion performance.



Oxide Lines (acceptable)

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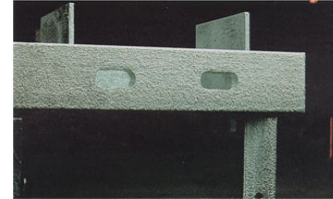


Finish of Galvanizing – Acceptable

Rough Surface

Rough surface/appearance is a uniformly textured appearance over the entire product. The cause for the rough surface is due to steel chemistry.

Rough surface condition can have a positive effect on corrosion performance because of the thicker zinc coating produced. Therefore, rough coatings are not cause for rejection.



Rough Surface Conditions (acceptable)



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Finish of Galvanizing – Acceptable

Rust Bleeding

Rust bleeding appears as a brown or red stain that leaks from unsealed joints after the product has been HDG.

It is caused by pre-treatment chemicals that penetrate an unsealed joint.

Over time, crystal residues absorb water from the atmosphere and attack both sides of the steel joint creating rust that seeps out.

Rust bleeding from unsealed joints is not the responsibility of the galvanizer and is not cause for rejection.



Rust Bleeding (acceptable)

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Finish of Galvanizing – Rejectable

Surface Contaminant

Contaminants on the steel not removed by pretreatment will create an ungalvanized area where the contaminant was originally located. Paint, oil, wax, lacquer that chemical cleaning cannot remove will cause this.

Parts are rejectable, if galvanizer is unable to catch all ungalvanized areas before shipping, galvanizer's customer will need to cover costs for repair due to initially adding contaminants.



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Weathering of Galvanized Steel – Wet Storage Stain



Photo taken 12/18/02

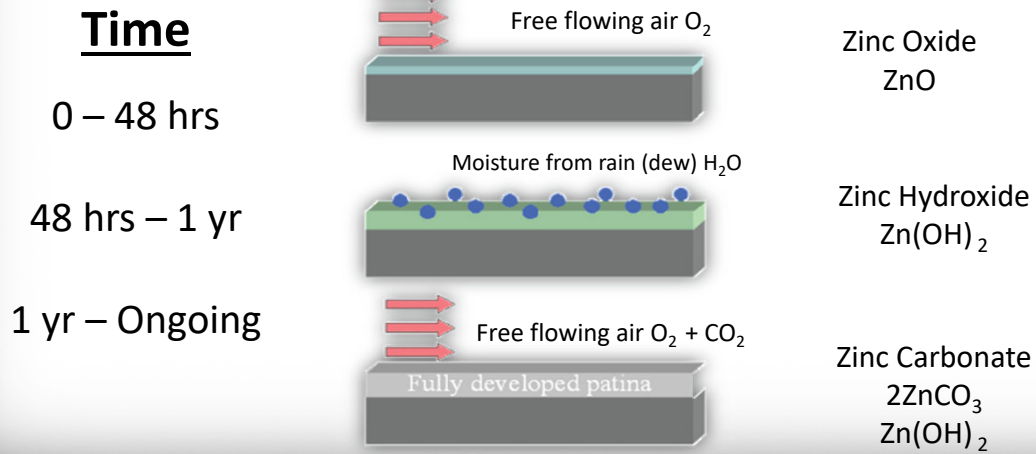


Photo taken 03/28/04

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Passivation Cycle



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Duplex Systems

Painting/Powder coating galvanized steel

- Aesthetic preference
- Branding/matching
- Safety/identification
- Repair existing structures



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Duplex Systems

Duplex systems provide more benefit than just aesthetic options.

- Synergistic effect – work together
- Additional barrier of protection
- 1.5 to 2.3 times service life
 - Example: At least 120 years ($1.5 \times (70 + 10)$)



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Questions & Comments



Brianasmith@azz.com

(775) 357-4074 – Cell

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