North American Galvanizing Company

The best results aren't by accident

Fabrication design solutions for hot dip galvanizing

04.2006

North American Galvanizing Company

The best results aren't by accident

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North American Galvanizing Company

Corporate Headquarters

5314 South Yale, Suite 1000
Tulsa, OK 74135
(918) 488-9420 Fax: (918)-488-8172
www.nagalv.com

Facility Locations

Canton

1723 Cleveland Avenue
S.W. Canton, OH 44707
(330) 445-2170
Fax: (330) 445-2172
Kettle: 52'L x 6'4"W x 8'6"D
16'L x 4'6"W x 5'6"D
Single lift capacity: 25,000

Dallas / Ft. Worth

625 West Hurst Blvd.
Hurst, TX 76053
(817) 268-2414
Fax: (817) 282-7793
Kettle: 42'L x 6'6"W x 7'6"D
Single lift capacity: 30,000 lbs

Denver

4400 East 61st Avenue
Commerce City, CO 80022
(303) 288-6631
Fax: (303) 288-0726
Kettle: 42'L x 5'W x 5'D
Single lift capacity: 15,000 lbs

Houston

9103 Fairbanks
North Houston Road
Houston, TX 77064
(832) 467-3772
Fax: (832) 467-4323
Kettle: 62'L x 8'W x 10'D
Single lift capacity: 40,000 lbs

Kansas City

7700 East 12th Street
Kansas City, MO 64126
(816) 241-4300
Fax: (816) 241-4303
Kettle: 30'L x 4'6"W x 5'6"D
Single lift capacity: 12,000 lbs

Louisville

6310 Kenjoy Drive
Louisville, KY 40214
(502) 367-6146
Fax: (502) 368-9653
Kettle: 42'L x 5'W x 6'D
Single lift capacity: 20,000 lbs

Nashville

200 32nd Avenue North
Nashville, TN 37209
(615) 297-9581
Fax: (615) 297-9582
Kettle: 51'L x 6'6"W x 8'6"D
Single lift capacity: 20,000 lbs

St. Louis

1461 Kin Ark Court
St. Louis, MO 63132
(314) 993-1562
Fax: (314) 993-3556
Kettle: 51'L x 7'3"W x 10'D
Single lift capacity: 30,000 lbs

Tulsa

1800 West 21st Street
Tulsa, OK 74107-2712
(918) 584-0304
Fax: (918) 584-1781
Kettle: 56'L x 5'3" W x 7'D
42'L x 6'6"W x 6'6"D
36L x 4'W x 6'D
Single lift capacity: 18,000 lbs

Contact any of our facilities via e-mail through our web site @ www.nagalv.com

North American Galvanizing Company

Hot Dip Galvanizing Customer Checklist

Avoid costly errors and delays by providing material that meets all design and fabrication requirements for hot dip galvanizing. High quality galvanizing results are contingent on design & fabrication compliance to ASTM A385 & A384.

1. **Coating requirements:** Verify coating specification/requirements (ASTM, AASHTO etc).

2. **Certification:** Check project for job specific certification (ASTM or other) requirements. Notify Galvanizer (in writing) prior to material processing. Additional charge may apply.

3. **Expectations:** Are there requirements beyond the normal ASTM specifications? What is the application & aesthetic expectations? Understand coating appearance characteristics. Consult NAGC.

4. **Steel composition:** Steel chemistry is the primary determining factor in both thickness and appearance of the galvanized coating. Certain elements like phosphorus (in excess of .04%) and silicon (in excess of .04%) or a combination of the two (exceeding .055%), can have a profound affect on appearance (color/luster) as well as coating thickness and smoothness, but not on the corrosion resistant properties. Refer to ASTM A385, section 3 "Steel Selection". Consult NAGC for review of steel composition mill certifications when aesthetics are important. Mixed material fabrications will have varying material compositions, potentially resulting in coating thickness, appearance and color (shiny/dull) variations. Due to concentrations of certain elements within the material, it is not uncommon to have coating color, luster (shiny/dull) variations on a single piece of steel. The corrosion resistance of normal and abnormal coatings is, for all practical purposes equal.

5. **Design & fabrication for galvanizing:** As required per ASTM A123, 5.2 design and fabrication shall comply with the ASTM A385, A384 & A143 guidelines. Consult NAGC for specific design (for galvanizing) instruction. Always provide a drawing or sketch in order to prevent any potential miscommunication.

6. **Size:** Check fabrication size in relation to the zinc kettle size. Will it fit, with room to maneuver?

7. **Angle Rule:** Whenever possible material will enter and exit the kettle at an angle. The objective is to prevent any portion of the fabrication from exiting the molten zinc completely horizontal or flat. Processing at an angle promotes the runoff of excess zinc, helping to minimize drips and runs. All fabrication for galvanizing designs including vent and drain hole locations for hollow/blocked sections, cropping corners for flow as well as determining suspending hole locations, should begin with this rule in mind. Small hanging rack material should have suspending holes located as to prevent a flat exit. Example: small, square or rectangular plates should always be suspended by a corner.

8. **Splice (double) dip:** If more than one dip is required in order to provide complete hot dip galvanized coverage (due to the size of the fabrication), the coating will have visible splice lines. All parties should have a clear understanding of the resulting splice line, overlap coating & possible splash.

9. **Provide clean material:** Surface contaminants can prevent the formation of the galvanized coating. It is the customers responsibility to remove all paint, mill lacquer, paint pen, mill markings, sticker-adhesive, grease, heavy rust, excessively heavy or rolled in mill scale and/or other foreign coatings or markings. Surface rust is ok. Consult NAGC regarding approved marking pen options that are easily and completely removable in the normal galvanizing process **(LA Co Markal Paint Stick #83420).**

10. **Castings and forgings:** All iron and steel castings and rod iron forged/sculptured pieces must be blasted (white blast) prior to galvanizing.

11. Welding: Select weld material with a similar composition to base steel. Most standard weld material contains reactive (>.50%) levels of silicon, resulting in a heavier than normal galvanized coating at the weld. Consult NAGC on low silicon weld material sources. All welds and the surrounding area must be clean and free of flux, slag or other foreign remnants or deposits. Note: the use of some anti- splatter chemicals (if not removed) can create voids in the galvanized coating.

12. Stitch vs. seal welding: Hot Dip Galvanizing requires a minimum separation of 3/32" between pieces in order to galvanize. Stitch welding of overlapped or contacting surfaces will not allow for galvanizing in between and eventual rust bleeding is a possibility. Furthermore, cleaning solutions between these surfaces can volatize during the galvanizing process and interfere with coating the adjacent areas. Seal welding prevents this problem, but may require additional venting (see **#**14).

13. Venting and draining hollow fabrications: While not always realistic, the objective is to vent or vacate 100% of the air in all hollow fabrications. All blocked ends require properly sized (min 15%), precisely located vent & drain holes to enable the free flow of cleaning solutions, fluxes, air & zinc, in order to achieve complete internal coating protection. Keep in mind the angle rule (see #7).

a. **Vent and drain hole location**: Consider how your material is suspended for processing. Note- whenever possible, material is suspended at a 30°- 45° angle, in order to promote zinc run off and produce a consistent, uniform coating. Determine high (air exit) points and low (zinc entry) points for precise, offset vent & drain hole locations. Always follow a consistent hole pattern across the fabrication. Place these offset vent holes directly up against the weld or edge. Note: The normal hole location requirements may change if the fabrication requires splice (double) dipping. Consult NAGC for specific instruction.
b. **Vent and drain hole size:** Calculate vent and drain hole sizes to equal a minimum of 15% of each hollow cross sectional area. Multiple, smaller holes that equal the same 15% is also acceptable. Vent and drain holes must always exceed the thickness of the material and an absolute minimum of 3/8". Consult NAGC for specific instruction.
c. **Internal venting:** See ASTM A385, section 11.3 & *fig* 7. Internal holes shall be the full inside diameter of the connecting piece. In addition, there shall be one 3/8" (minimum) external hole at each connection to prevent any possible explosion, in the event that an internal hole is missed. Always consult NAGC regarding internal venting.

14. Destructive pressure vent holes: Trapped air and/or moisture between overlapped, seal-welded surfaces can result in the buildup of destructive pressures during galvanizing. Seal welded areas >16 square inches, up to 50 square inches will require a single, centrally located vent hole through one or both of the connecting pieces. The vent hole size should be ≥ the thickness of the material and an absolute minimum of 3/8". Additional, equally spaced (over surface area), destructive pressure vent holes are required for each additional 50 square inches of surface area. Example: 16-50 sq in = 1 hole, 51-100 sq in = 2 holes, 101-150 sq in =3-holes etc.

15. Cropping corners & flow holes: Gussets, stiffeners, end plates and other fabrication designs that create corner pockets or blocked areas will prevent the free flow of cleaning solutions, fluxes, air & zinc. These areas require cropped corners or flow hole openings in order to prevent trapped ash, coating voids or pooled zinc and produce a complete, consistent coating. Cropped or flow hole size openings should always exceed the thickness of the material and an absolute minimum of 3/8". Consult your galvanizer.

16. Suspending (hanging) holes: Some pieces may require hanging holes (3/8" minimum) or other means in order to suspend for processing. Consult your NAGC facility for specific requirements. Small hanging rack material should have suspending holes located as such to prevent a flat exit from the molten zinc. Example: square or rectangular plates should always be suspended by a corner.

17. **Heat distortion/warping:** Refer to ASTM A384. Avoid mixed material thickness (due to varying expansion and contraction rates) on the same fabrication. Design structures to be single dipped rather than splice (double) dipped. Whenever possible use symmetrical shaped material (I-beam, pipe, tube) over non-symmetrical (angle, channel etc). Avoid long fabricated sections of thin material. Fabricate handrail separate from structures and keep handrail lengths to 20' or less.

18. **Loose identification tags:** Secure loose metal tags with a minimum 12 gage steel wire.

19. **Secondary coatings over galvanizing:** Advise the galvanizer (in advance) if the material will receive a secondary coating over the galvanizing in order to prevent the use of zinc rich touch up paints that could react to the secondary coating. Refer to ASTM D6386 for preparation of the galvanized material to accept secondary coatings. If sweep blasting is utilized to profile (etch) the galvanized coating, use only approved media and measure the coating thickness after blasting to ensure that sufficient coating thickness remains.
Regardless of method, once profiled, the application of secondary coatings should take place in a timely manner(48-72 hours typ), prior to the formation of zinc oxides (white rust). Always wash the profiled surface with clean water and allow to dry prior to applying secondary coatings. Consult your NAGC sales representative or facility for available profiling options including chemical etching.

20. **Preventing galvanizing on specific areas:** Consult galvanizer on approved methods for preventing galvanizing on specific areas for field welding or protecting male or female threads etc.

21. **Moving Parts:** Avoid hot dip galvanizing connected, moving pieces. Remove or disassemble any hinged pieces, doors, lids, sliding pieces, locks etc. and reassemble after galvanizing.

22. **Repair options for damaged or uncoated areas:** ASTM A780 – Standard Practice for Repair of Hot Dip Galvanized Coatings. These ASTM approved repair methods include metalizing (flame sprayed zinc), zinc based alloys and ASTM approved zinc dust repair paint. Consult NAGC or refer to ASTM A780 for preparation and application requirements.

23. **Inbound & outbound loads:** Make sure that incoming loads are elevated and or palletized on flat bed trailers for easy fork-truck offloading. Keep individual lifts to 5-tons maximum. Do not nest I-beams. Prevent manual handling of small/loose pieces (secure to pallets or place in containers). Providing adequate dunnage, skids/pallets, crates etc, in order to facilitate a safe secure load and protect the galvanized coating is the responsibility of the customer. 4"x 4"x 8' spacing dunnage will provide sufficient separation. 2"x 4", 2"x 2" and smaller spacing dunnage can create problems and possible damage to the galvanized coating during reloading due to lift truck forks being 3-1/2" thick. Use straps (not chains) to secure and protect all outbound loads.

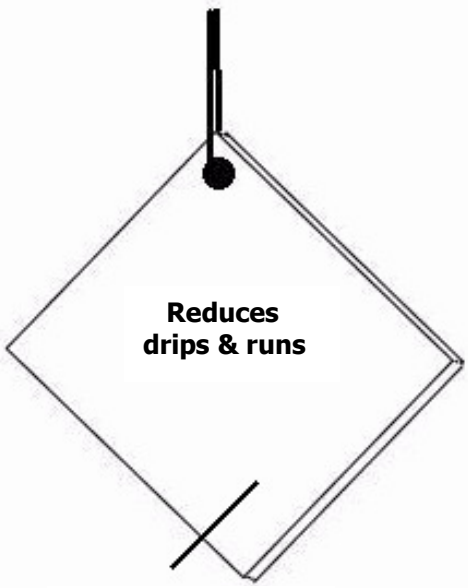
24. **Wet storage stain:** Trapped moisture between poorly ventilated, galvanized pieces can develop wet storage stain or white oxidation (aka white rust). Storage of galvanized material requires separation of individual pieces to allow free flowing air to all coated surfaces. Material stored outside should rest at a slight incline to prevent pooling of water. Wet storage staining is not usually detrimental to the corrosion protection and generally disappears during the normal weathering process of the galvanized coating.

The Angle Rule
How your material is suspended

Whenever possible, material will enter and exit the kettle at an angle. The objective is to prevent any portion of the fabrication from exiting the molten zinc completely horizontal or flat. Processing at an angle promotes the runoff of excess zinc, helping to minimize drips and runs.

All fabrication for galvanizing designs including vent and drain hole locations, cropping corners and flow holes as well as determining suspending hole locations, should begin with the angle rule in mind.

Flat sides exiting molten zinc increases drips and runs.



Hanging by a corner promotes runoff of excess zinc, minimizing drips & runs.

Small hanging rack material that cannot be manipulated at an angle (for processing) should always have suspending holes located as to prevent a flat exit from the molten zinc. Example: square or rectangular plates should always be suspended by a corner. See *figure left.*

Venting and draining hollow fabrications

All hollow, sealed fabrications must be properly vented in order to prevent dangerous explosions and safely process hollow material to achieve a complete, internal and external hot dip galvanized coating as described in ASTM A385.

The galvanizers ability to meet ASTM A123 and provide high quality results, are contingent on adequate venting and draining practices. These vent and drain openings allow for the free flow of cleaning and pickling solutions as well as the flow of air and molten zinc.

Correctly sized and precisely located vent and drain openings are essential in preparing the internal steel surfaces to accept the formation of the galvanized coating.

Any entrapment of chemicals or air during the galvanizing process will result in coating voids and/or other coating related defects.

When uncertain about the venting and draining requirements for your specific fabrication or project, please contact your North American Galvanizing Company representative for instruction.

Providing a drawing or sketch of the hollow fabrication or structural member is highly recommended as a means to insure precise instruction and reduce the potential for costly miscommunications.

The vent hole size requirements on each hollow fabrication are directly related to the (inside) cross-sectional area of each blocked section, within the piece in question. Complete open ends or openings of 30%-50% of the cross sectional area will produce the best hot dip galvanizing results and allow for faster processing.

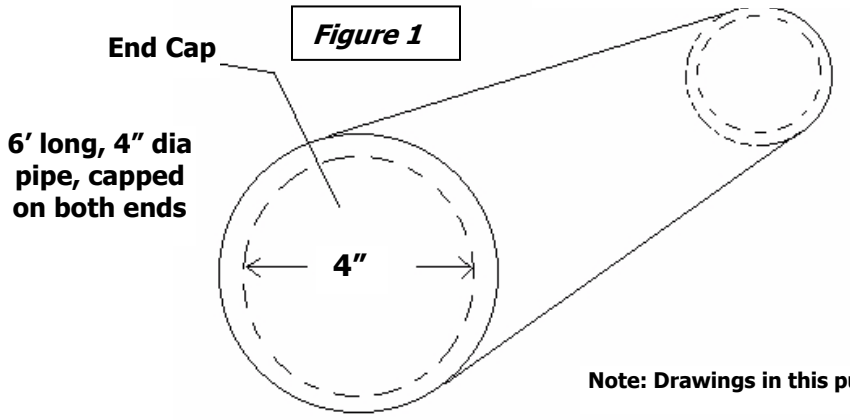
Most (fabrication design for galvanizing) publications including ASTM A385 require minimum vent opening of 25 - 30% of the cross sectional area. North American Galvanizing Company does allow a minimum vent hole size equal to 15% of the (inside) cross sectional area. If desired, this 15% can be made up of 2 or more smaller holes that provide equivalent openings.

The precise placement of these correctly sized vent and drain openings are crucial to obtaining high quality results. It is essential to understand how the specific fabrication or structure will be suspended during processing.

Whenever possible, material enters and exits each step of the process at an angle (30-45° typ). This helps promote the flow and draining of the chemical solutions as well as effective runoff of excess zinc, required to produce a complete, consistent coating, while minimizing drips and runs.

The following information will illustrate basic vent and drain opening designs beginning with a simple (sealed) pipe fabrication (*see figure 1*).

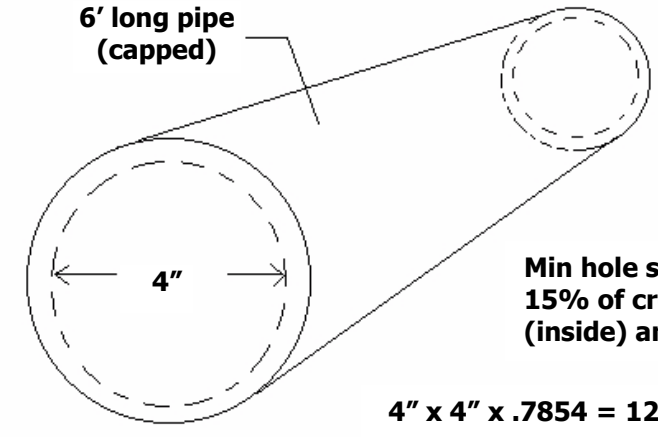
Figure 1



Note: Drawings in this publication are not to scale.

Determining Vent Hole Size & Location

Figure 2



Min hole size calculation: 15% of cross-sectional (inside) area.

4" x 4" x .7854 = 12.57 sq. in.

12.57" x .15 = 1.89 sq. in.

For the above fabrication, the minimum opening should be 1.89 sq. in. or a single, round hole diameter of 1.55". Multiple holes equal to the same 15% can also be used. All vent and drain openings must be ≥ the thickness of the material and an <u>absolute minimum of 3/8".</u>

First determine the square inch cross sectional (inside) area of the fabrication to be galvanized.

For the simple pipe fabrication as shown in *figure 2*, calculate the inside cross-sectional square inch area as shown: I.D.(inside dia) x I.D. x .7854 = cross sectional inside area.

Multiply the cross sectional area by .15 to determine the 15% minimum square inch vent and drain opening requirement. If desired, this 15% can be made up of 2 or more smaller holes that provide equivalent openings.

In order to prevent the vent holes from trying to fill in during the galvanizing process, the vent hole size must always be greater than the thickness of the material and an absolute minimum of 3/8".

As mentioned previously, whenever possible, the material will enter and exit the kettle at an angle (*see figure 3*).

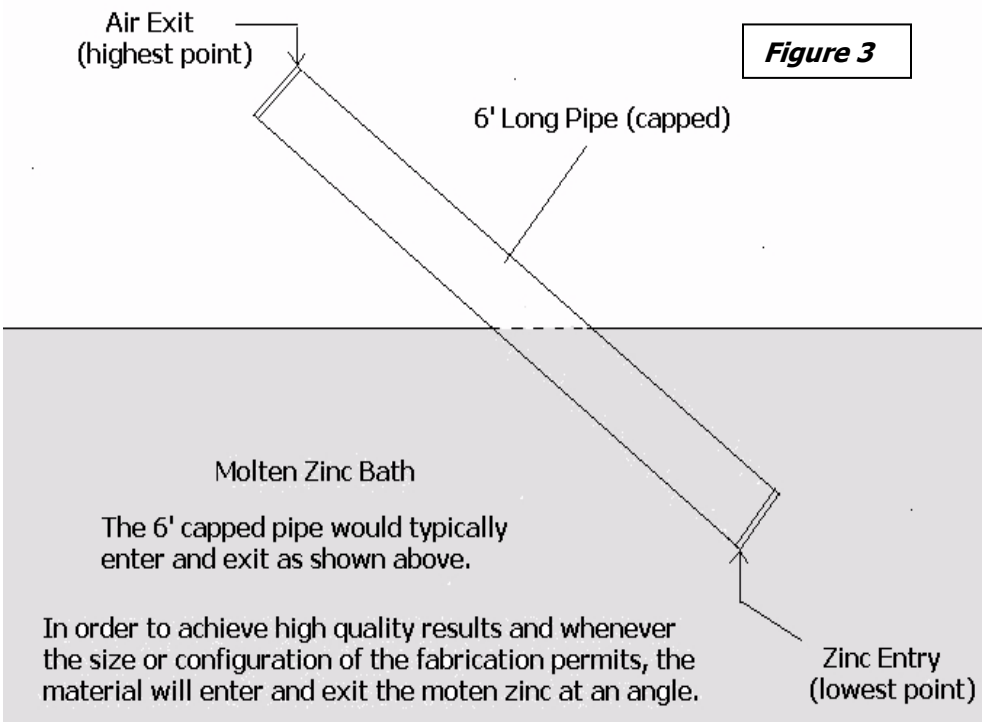
It is important to understand how each different fabrication will be suspended for processing in order to determine the highest (air exit) and the lowest (zinc entry) points.

Keep in mind, due to the material processing at an angle, the resulting (high and low) locations are most often <u>offset</u>.

Determining the high and low points of each blocked, hollow section of the fabrication will provide the means to remove up to 100% of the air, thus allowing for a complete internal coating.

Consider how the material will enter and exit the kettle.

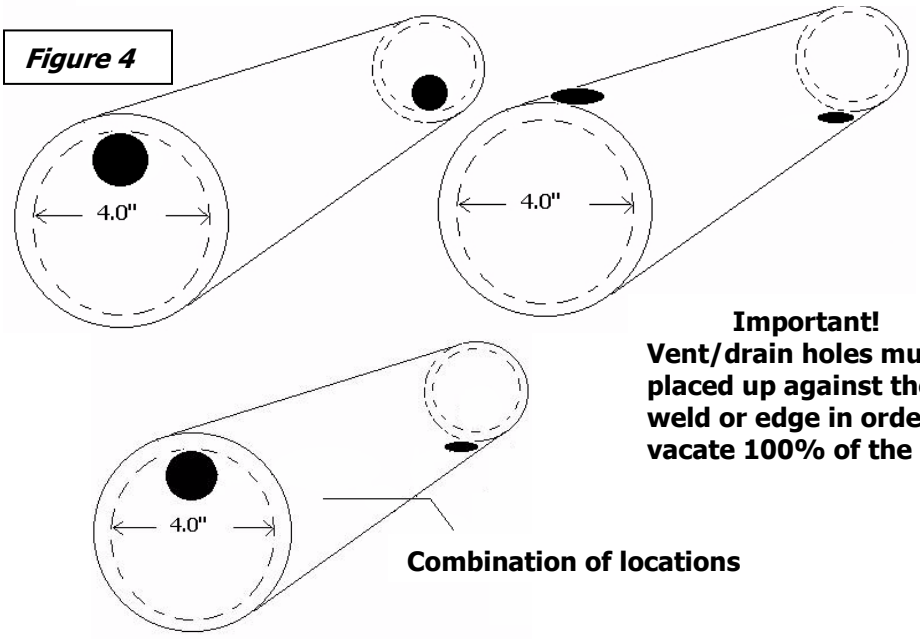
Figure 3



Vent Hole Location Options

The minimum (single hole) vent/drain requirements can be met by locating the correctly sized, <u>offset holes</u> through the cap or the pipe or combination of the two.

Figure 4



Important!
Vent/drain holes must be placed up against the weld or edge in order to vacate 100% of the air.

Combination of locations

In many cases, once the high and low points are determined, more than one vent hole location option may be available.

In the case of the 6' long, capped pipe *(figure 4*), effective venting can be accomplished by <u>offset</u> holes located either through the end caps or through the pipe itself.

Holes should always be placed up against the weld or edge in order to vacate 100% of the air.

A combination of the locations (one hole in the pipe and the other in the cap) would also produce equal results as long as the high and low point requirements are met.

Figure 5 shows how these vent/drain hole options will function.

Determining the vent hole location is as important as the hole size.

Trapped air creates voids in the galvanized coating as well as increasing the potential for other defects including ash inclusions and trapped or pooled zinc.

While not always realistic (due to design issues or cosmetic requirements) the goal remains to vent or vacate as close to 100% of the air as possible in all hollow fabrications.

The same holes that allow the molten zinc to enter the hollow areas of the fabrication become drain holes as the piece is being extracted from the kettle.

Figure 5

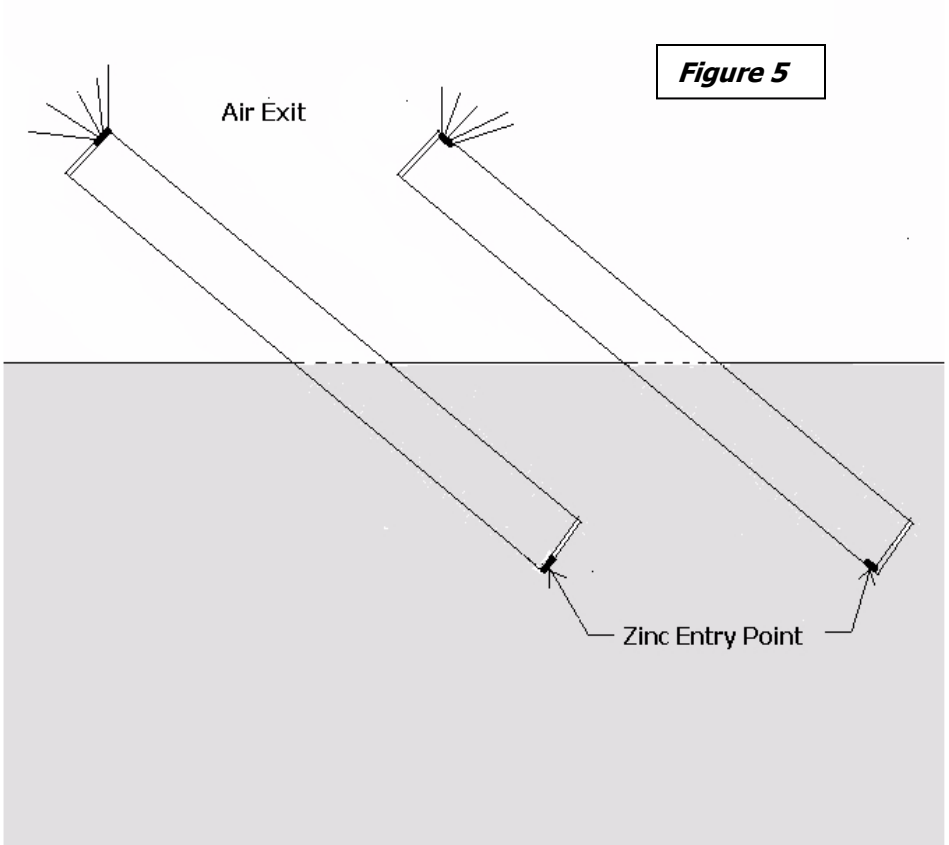
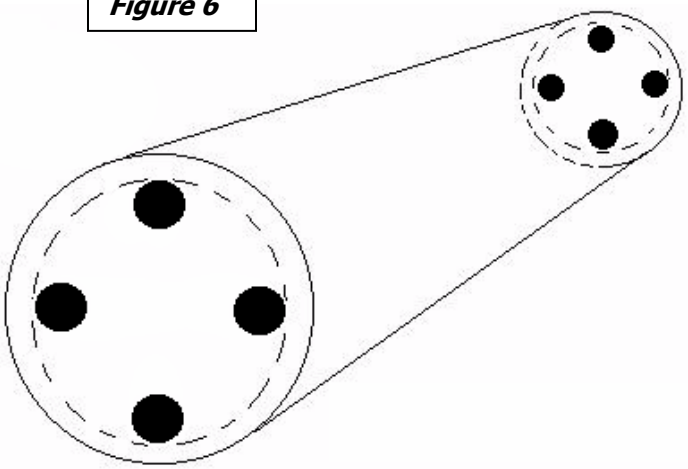


Figure 6



Multiple, smaller vent and drain holes, combined to meet or exceed the same minimum (15%) opening requirement, will produce equal results as long as the high (air exit) and low (zinc entry) points are covered (see *figure 6).*

Refer to the following minimum vent/drain hole sizing charts for specific pipe and square tube sizes utilizing 1, 2 & 4 hole designs. The square inch, or equivalent round hole size is based on the minimum 15% of the cross sectional area for the specific pipe and square tube sizes listed.

The following minimum (non-handrail) vent/drain hole sizes reflect the size requirement per hole. Example: The 4-vent size is the required per hole size if four equal holes are used per blocked section as pictured above. See page 15 for the minimum vent/drain hole size requirements for handrail.

Vent and drain holes for hollow (pipe) fabrications

NAGC minimum vent/drain hole requirement (15% of cross sectional area) (non - handrail)

Pipe Inside Dia"	Cross Sec Sq In.	15% of Cross Sec (sq. in.)	Single Vent Hole Dia	2 - Vent Min Sq In.	2 - Vent Hole Dia	4 - Vent Min Sq In.	4 - Vent Hole Dia
2.00	3.14	0.47	**0.77**	0.24	**0.55**	0.12	**0.39**
2.50	4.91	0.74	**0.97**	0.37	**0.68**	0.18	**0.48**
3.00	7.07	1.06	**1.16**	0.53	**0.82**	0.27	**0.58**
3.50	9.62	1.44	**1.36**	0.72	**0.96**	0.36	**0.68**
4.00	12.57	1.88	**1.55**	0.94	**1.10**	0.47	**0.77**
4.50	15.90	2.39	**1.74**	1.19	**1.23**	0.60	**0.87**
5.00	19.64	2.95	**1.94**	1.47	**1.37**	0.74	**0.97**
5.50	23.76	3.56	**2.13**	1.78	**1.51**	0.89	**1.07**
6.00	28.27	4.24	**2.32**	2.12	**1.64**	1.06	**1.16**
7.00	38.48	5.77	**2.71**	2.89	**1.92**	1.44	**1.36**
8.00	50.27	7.54	**3.10**	3.77	**2.19**	1.88	**1.55**
10.00	78.54	11.78	**3.87**	5.89	**2.74**	2.95	**1.94**
12.00	113.10	16.96	**4.65**	8.48	**3.29**	4.24	**2.32**

NAGC minimum vent/drain hole requirement (same as above in 16ths)

Pipe Inside Dia"	Cross Section Sq In.	15% of Cross Sec (sq. in.)	Single Vent Hole Dia	2 - Vent Min Sq In.	2 - Vent Hole Dia	4 - Vent Min Sq In.	4 - Vent Hole Dia
2	3 2/16	0.47	**12/16**	0.24	**9/16**	0.12	**6/16**
2 1/2	4 15/16	0.74	**15/16**	0.37	**11/16**	0.18	**8/16**
3	7 1/16	1.06	**1 3/16**	0.53	**13/16**	0.27	**9/16**
3 1/2	9 10/16	1.44	**1 6/16**	0.72	**15/16**	0.36	**11/16**
4	12 9/16	1.88	**1 9/16**	0.94	**1 2/16**	0.47	**12/16**
4 1/2	15 14/16	2.39	**1 12/16**	1.19	**1 4/16**	0.60	**14/16**
5	19 10/16	2.95	**1 15/16**	1.47	**1 6/16**	0.74	**15/16**
5 1/2	23 12/16	3.56	**2 2/16**	1.78	**1 8/16**	0.89	**1 1/16**
6	28 4/16	4.24	**2 5/16**	2.12	**1 10/16**	1.06	**1 3/16**
7	38 8/16	5.77	**2 11/16**	2.89	**1 15/16**	1.44	**1 6/16**
8	50 4/16	7.54	**3 2/16**	3.77	**2 3/16**	1.88	**1 9/16**
10	78 9/16	11.78	**3 14/16**	5.89	**2 12/16**	2.95	**1 15/16**
12	113 2/16	16.96	**4 10/16**	8.48	**3 5/16**	4.24	**2 5/16**

Vent and drain holes for hollow (square tube) fabrications

NAGC minimum vent/drain hole requirement (15% of cross sectional area)
(non - handrail)

Square Tube size "	Cross Sec Sq In.	15% of Cross Sec (sq. in.)	Single Vent Hole Dia	2 - Vent Min Sq In.	2 - Vent Hole Dia	4 - Vent Min Sq In.	4 - Vent Hole Dia
2.00	4.00	0.60	**0.87**	0.30	**0.62**	0.15	**0.44**
2.50	6.25	0.94	**1.09**	0.47	**0.77**	0.23	**0.55**
3.00	9.00	1.35	**1.31**	0.68	**0.93**	0.34	**0.66**
3.50	12.25	1.84	**1.53**	0.92	**1.08**	0.46	**0.76**
4.00	16.00	2.40	**1.75**	1.20	**1.24**	0.60	**0.87**
4.50	20.25	3.04	**1.97**	1.52	**1.39**	0.76	**0.98**
5.00	25.00	3.75	**2.19**	1.88	**1.55**	0.94	**1.09**
5.50	30.25	4.54	**2.40**	2.27	**1.70**	1.13	**1.20**
6.00	36.00	5.40	**2.62**	2.70	**1.85**	1.35	**1.31**
7.00	49.00	7.35	**3.06**	3.68	**2.16**	1.84	**1.53**
8.00	64.00	9.60	**3.50**	4.80	**2.47**	2.40	**1.75**
10.00	100.00	15.00	**4.37**	7.50	**3.09**	3.75	**2.19**
12.00	144.00	21.60	**5.24**	10.80	**3.71**	5.40	**2.62**

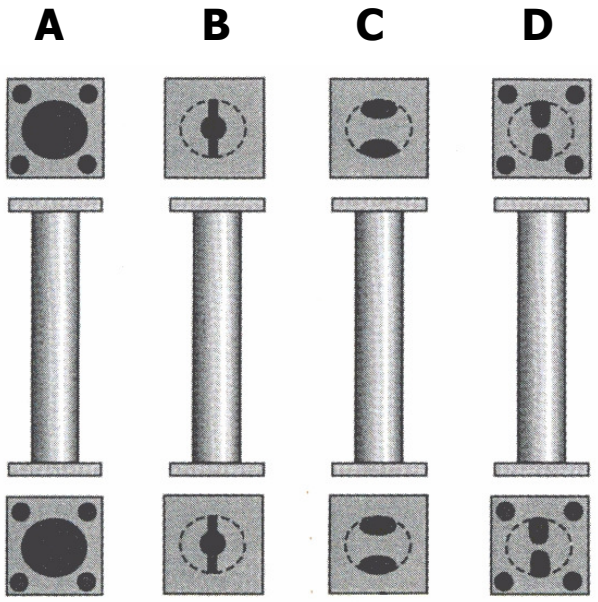
NAGC minimum vent/drain hole requirement (same as above in 16ths)

Square Tube size "	Cross Section Sq In.	15% of Cross Sec (sq. in.)	Single Vent Hole Dia	2 - Vent Min Sq In.	2 - Vent Hole Dia	4 - Vent Min Sq In.	4 - Vent Hole Dia
2	4	10/16	**14/16**	0.30	**10/16**	0.15	**7/16**
2 1/2	6 4/16	15/16	**1 1/16**	0.47	**12/16**	0.23	**9/16**
3	9	1 6/16	**1 5/16**	0.68	**15/16**	0.34	**10/16**
3 1/2	12 4/16	1 13/16	**1 8/16**	0.92	**1 1/16**	0.46	**12/16**
4	16	2 6/16	**1 12/16**	1.20	**1 4/16**	0.60	**14/16**
4 1/2	20 4/16	3 1/16	**1 15/16**	1.52	**1 6/16**	0.76	**1**
5	25	3 12/16	**2 3/16**	1.88	**1 9/16**	0.94	**1 1/16**
5 1/2	30 4/16	4 9/16	**2 6/16**	2.27	**1 11/16**	1.13	**1 3/16**
6	36	5 6/16	**2 10/16**	2.70	**1 14/16**	1.35	**1 5/16**
7	49	7 6/16	**3 1/16**	3.68	**2 3/16**	1.84	**1 8/16**
8	64	9 10/16	**3 8/16**	4.80	**2 8/16**	2.40	**1 12/16**
10	100	15	**4 6/16**	7.50	**3 1/16**	3.75	**2 3/16**
12	144	21 10/16	**5 4/16**	10.80	**3 11/16**	5.40	**2 10/16**

Pipe columns, poles or other straight pipe or round tube fabrications with base plates or end caps can be adequately vented utilizing the various vent hole designs illustrated in *figure 7*.

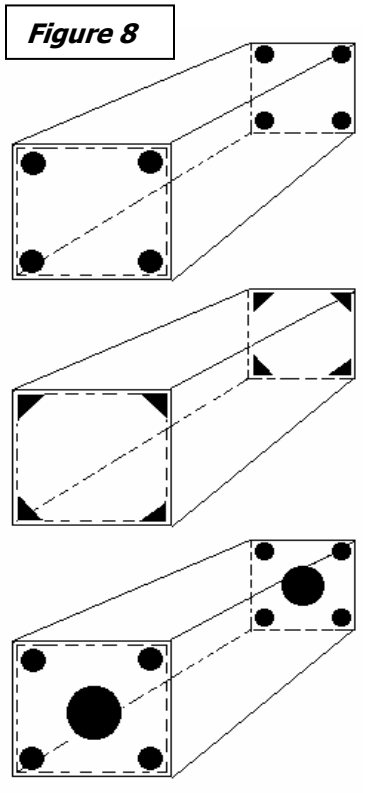
These vent hole designs are preferable and provide excellent results as illustration A is completely open and B, C & D provide both high and low openings on each end.

Figure 7



Vent/drain designs for square/rectangular tube fabrications

Figure 8



The same venting principles apply to square and rectangular fabrications as the material will, in most cases, enter and exit the kettle at an angle.

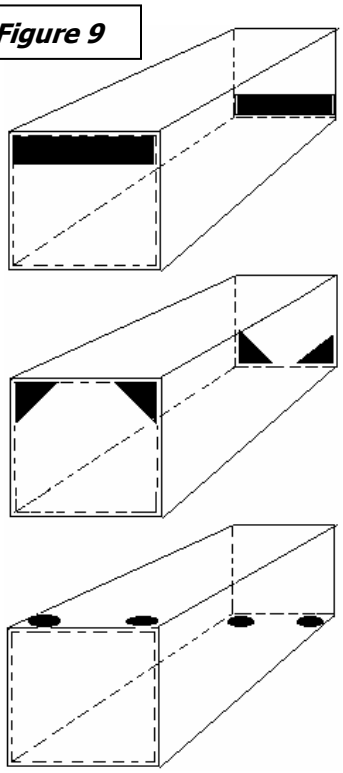
The same minimum 15% vent opening is required.

Parallelogram shapes run better if all corners are open as shown in *figure 8*.

Offset openings (*figure 9*) are also permitted as long as the minimum 15% requirement is met.

As was the case on the pipe fabrication, offset vent openings in the tube (*figure 8 bottom)*, rather than the end cap or base plate can also meet the minimum requirements, if properly located.

Figure 9



Square or rectangular shapes vent and drain better if a minimum of 2 corners are opened at each end (*see figure 10),* rather than a single, centrally located hole as shown in *figure 11.*

Material can shift and tilt during the hot dip galvanizing process, potentially trapping zinc in the corners when the single vent/drain hole system is used on square or rectangular shapes.

Trapped zinc increases the galvanizing prices, as CWT prices are generally applied to the actual post-galvanizing weights.

Keep in mind that covering two corners allows for smaller sized holes.

Figure 10

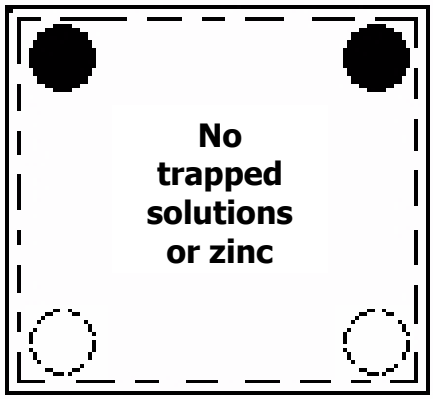
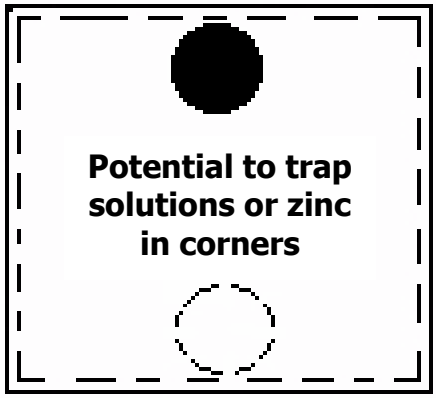


Figure 11



By applying these same practices to the (single dip size) tube frame (*figure 12*), near 100% internal coverage is achievable.

By keeping in mind that the tube frame will enter and exit the kettle at an angle, the high (air exit) and low (zinc entry) points of each section can be determined.

In this case the fabricator is using (2) zinc entry holes and (2) air exit holes in each blocked tube section. The combined opening for 2 holes meets the minimum 15% opening requirement for each end of every blocked section.

As shown in (*figure 13*) locating the holes directly in the corners provide the best opportunity for optimum flow, resulting in complete internal coverage.

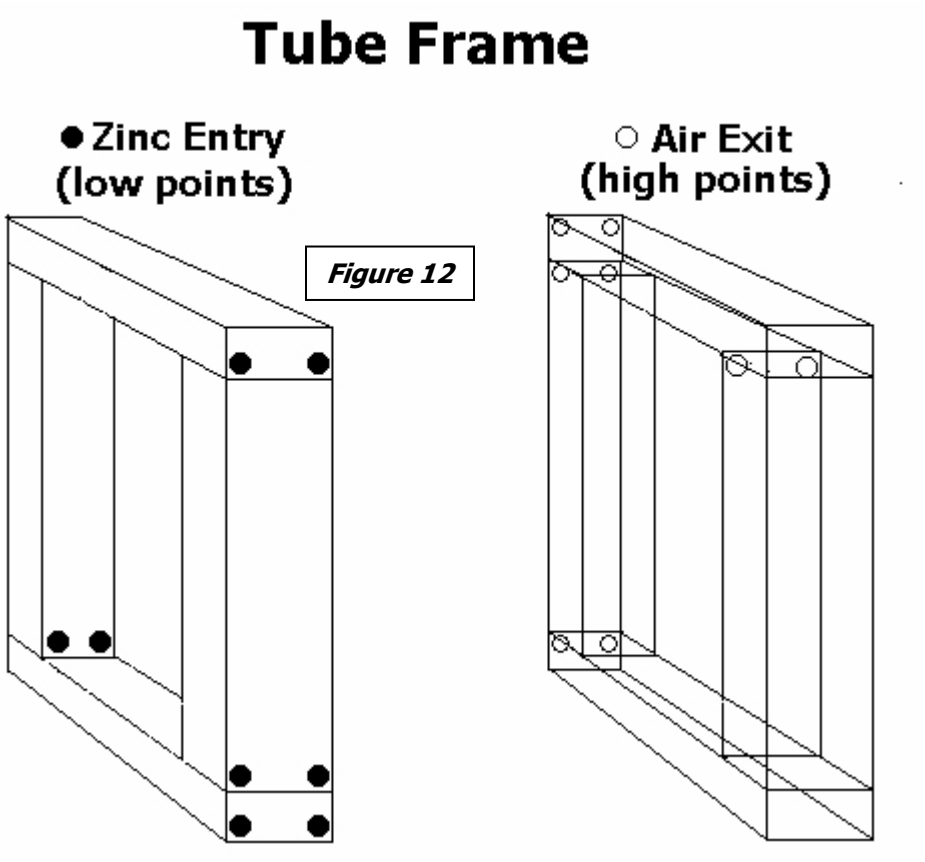


Figure 12

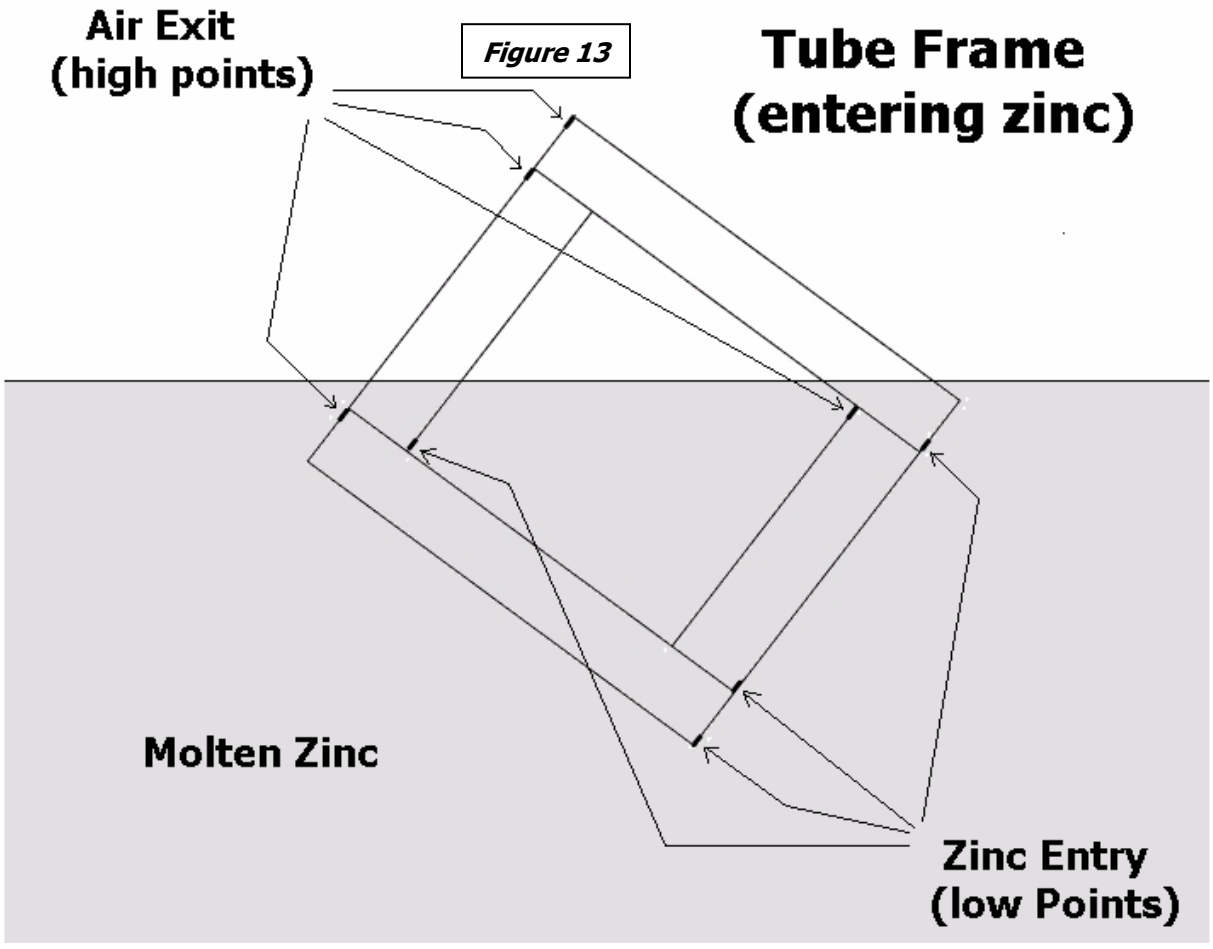
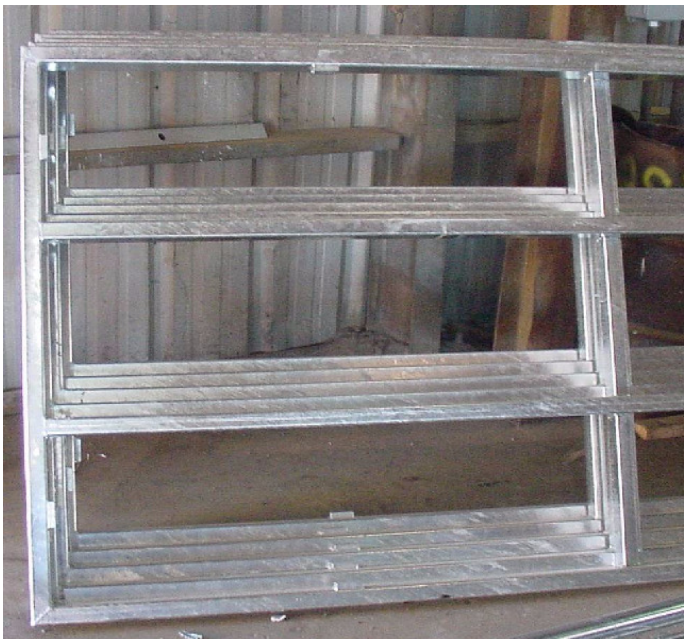


Figure 13



This tube frame (left) was vented with a single hole (per blocked end) design. The vent holes were incorrectly located approximately 1.5” from the weld.

As the frame exited the kettle at an angle, molten zinc was trapped back, behind the vent holes.

Once out of the kettle, the frame is stood straight and the trapped molten zinc begins to escape through the poorly located vent/drain holes.

This results in heavy drips and runs (see photos below) on the vertical sections as well as spilling onto the horizontal lines beneath the leaking holes.

Seemingly minor details like these critical hole locations can have a major impact on the coating results.

Venting smaller (hanging rack) fabrications

Larger fabrications typically allow for standard processing fixtures providing a means to enter and exit the process at an angle.

Smaller fabrications are generally suspended by a single wire on a hanging rack and are more difficult to manipulate at specific angles.

Figure 14 shows a small plate & pipe fabrication. This piece should hang from a single corner to prevent any plate sections from exiting the kettle flat.

Once the suspending hole location is determined, the placement of the correctly sized (min 15%) high and low vent/drain holes can follow (*fig 15)*.

Understanding how the piece will hang from the suspending hole will help locate the high and low points of the hollow section (*fig 16)*.

The suspending hole size should be ≥ the thickness of the material and an absolute minimum of 3/8".

Figure 14

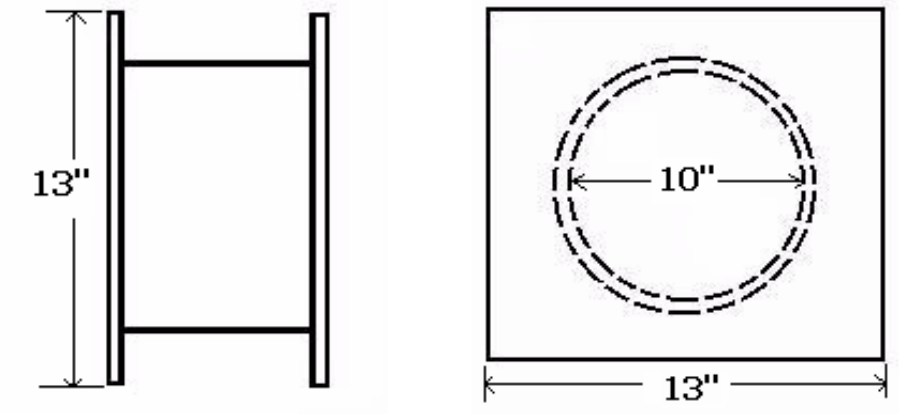


Figure 15

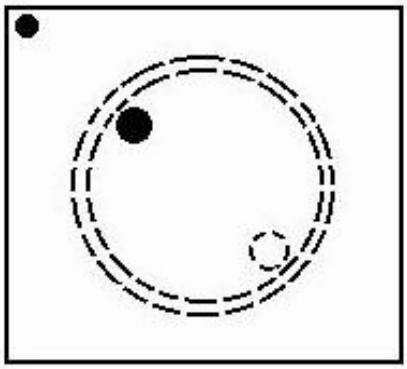
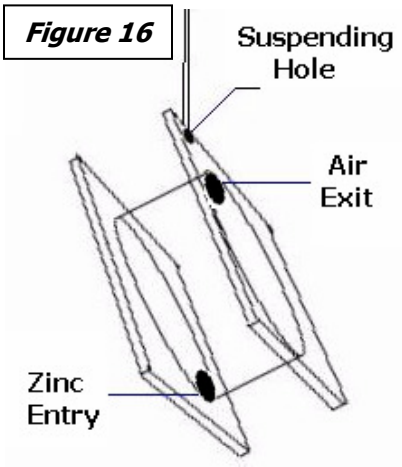


Figure 16



Vent/drain pipe handrail - <u>External</u> system

In most cases, handrail will enter and exit the kettle standing upright (rather than laying down) but also at an angle to insure fluid runoff of excess zinc.

Review the typical, single dip, handrail venting illustration (*figure 17)*.

For optimum results, handrail should always be fabricated and galvanized separate from platforms or stair stringers.

Due to the visibility and cosmetic aspirations for handrail, both vent and drain holes are permitted underneath on the horizontal sections, as long as the handrail can be single dipped. Smaller sized vent & drain holes are also permitted for the same aesthetic reasons.

Keep in mind that drilled (rather than torched) holes provide a more consistent flow during processing and are more easily repaired without damaging the galvanized coating. Contact NAGC about tapered vent/drain hole plugs (see page 20) for repairing drilled vent & drain holes.

Drilled vent and drain holes should be placed prior to assembly of the fabrication in order to insure that the holes will be located up against the weld as shown in *figure 17*.

NAGC will accept round vent and drain holes with a minimum diameter measuring ≥ 25% of the inside diameter of the pipe. This is the absolute minimum vent /drain hole size permitted on **<u>HANDRAIL ONLY.</u>** The minimum hole size must meet or exceed the thickness of the material in question and <u>never less than 3/8"</u> (*see min hole size charts below*).

Note the hole pattern on *figure 17*. All vent holes are located on the same side of the vertical posts. Processing material at an angle necessitates that a consistent vent hole location pattern be followed across the fabrication.

Base plate holes into the posts must be completely open as shown.

Each blocked end must have a vent hole, including short extensions.

Additional or relocated holes will be required for splice (double) dipping if the height of the fabricated handrail exceeds the depth of the galvanizer's kettle.

Vent holes on 90 degree turns (*figure 17)* should be located in the center of the bend as shown below.

External venting for <u>single dip</u> handrail

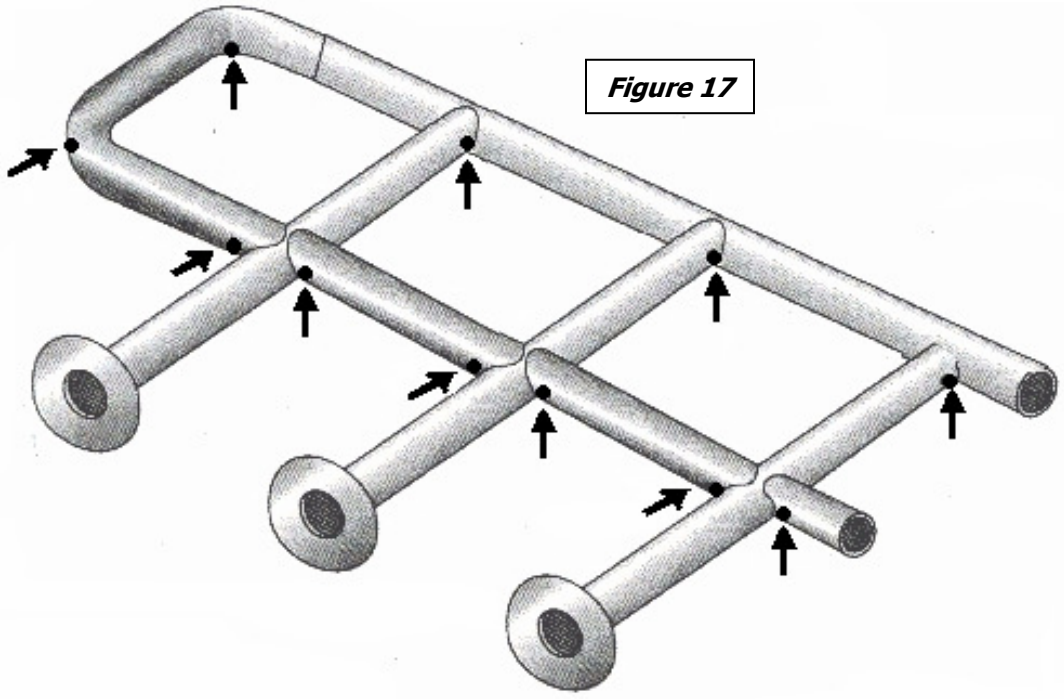


Figure 17

Minimum vent/drain Hole size <u>handrail only</u> (25% of the diameter) <u>absolute minimum of 3/8"</u>

Pipe <u>diameter</u>	**Minimum <u>hole size</u>**
1"	**3/8"**
1-1/2"	**3/8"**
2"	**1/2"**
2-1/2"	**5/8"**
3"	**3/4"**

Venting pipe handrail (examples)

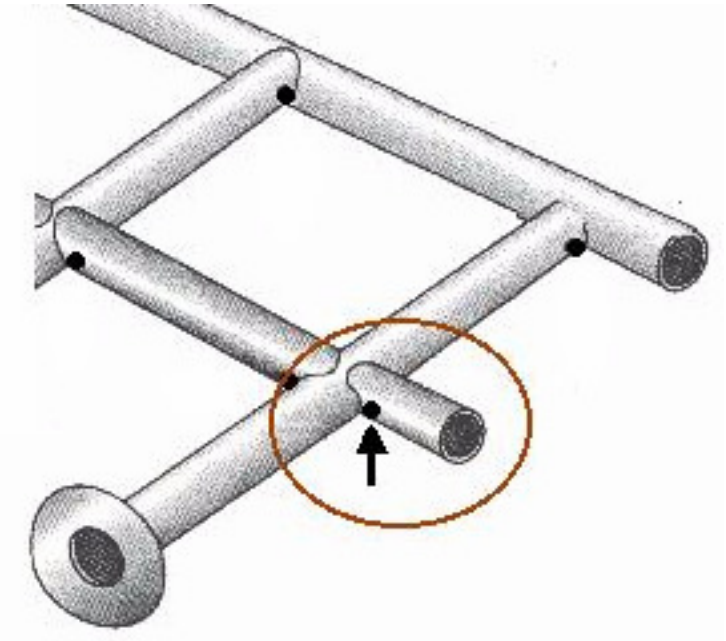
Vent /drain holes too far away from weld

Increases runs and drips

Vent /drain holes up against the weld

Smoother more consistent coating

Extensions require vent holes



Results if extensions not vented

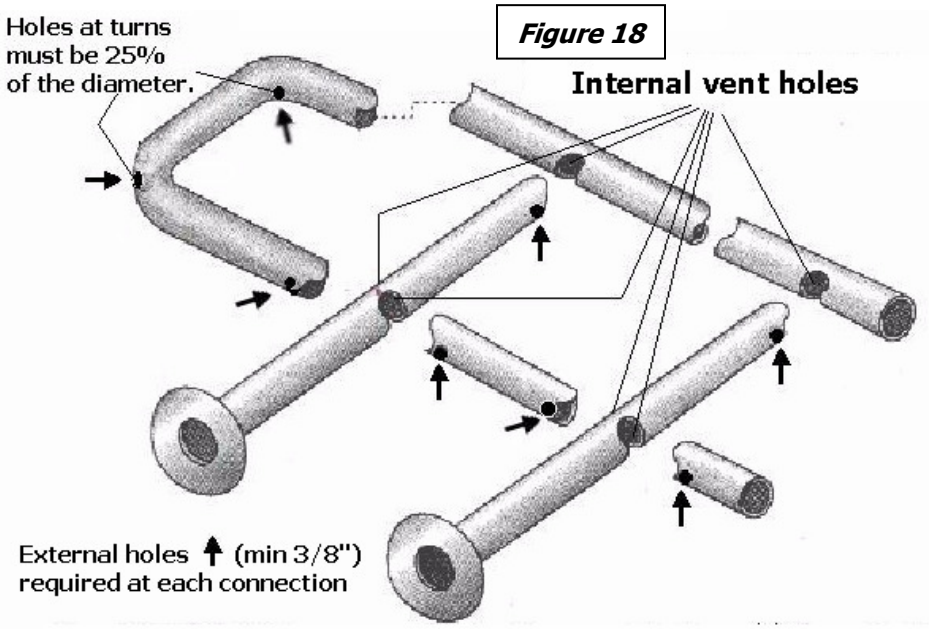
Vent/drain pipe handrail - <u>Internal</u> system

Internal Venting as shown in *figure 18* is an effective method for providing free flow of solutions, air and zinc.

However, this design does require additional fabrication time and can produce a weaker structure as all internal holes must be sized equal to the inside opening of the connecting piece.

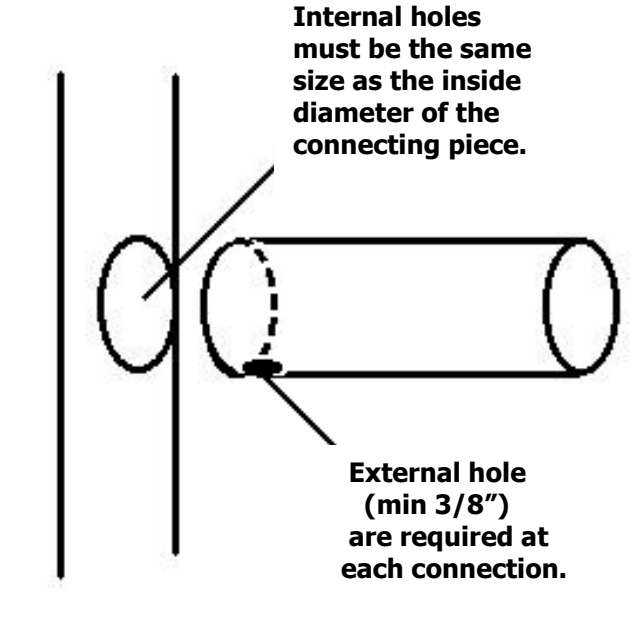
The possibility exists that an internal hole could be missed. This is a serious safety concern for the galvanizer's kettle workers, due to the potential for an explosion caused by trapped air, thus <u>external</u> holes are required at each connection.

Figure 18



As per ASTM A385, section 11.3, external holes (min 3/8") are required at each connection, to prevent any possible explosion in the event that an internal hole is missing.
All internal vent/drain holes must equal the inside diameter/dimension of the connecting piece.
Holes at the turn or bend must be 25% of the inside diameter and located as shown above at the 90° bends.

Figure 19



NAGC as well as ASTM A385 require that all internal vent holes include an <u>external</u> (minimum 3/8") vent hole (*see figure 19*) at each connection as a safety precaution

As per *ASTM A 385, section 11.3*, internal vent holes or openings must be the same size as the inside diameter or square inch opening of the connecting piece.

Much the same as externally vented handrail, internally vented rail still requires <u>external</u> holes in the center of each turn or bend. Holes at the turn/bend must have a diameter that is ≥ 25% of the inside diameter of the pipe and not less than 3/8" (*see figure 18*).

North American Galvanizing Company

Hot Dip Galvanizing - Vent Hole Plugs

Repair vent holes without damaging the galvanized coating!

Eliminate cold galvanizing repairs!

Quick & Easy - Save time & $$ by plugging holes!!

Prevent exposure to zinc fumes!

2006 Pricing

Tapered Vent Hole Plugs - Aluminum & Zinc

Plug Size	Per Plug <100	100 Count	Per Plug 100 - 249	250 Count	Per Plug 250 - 499	500 Count	Per Plug 500 - 999	1000 Count	Per Plug 1,000-UP
3/8"	$0.50	$ 42.00	$ 0.42	$ 80.00	$0.320	$ 142.00	$0.284	$ 264.00	$ 0.264
7/16"	$0.50	$ 42.00	$ 0.42	$ 80.00	$0.320	$ 142.00	$0.284	$ 264.00	$ 0.264
1/2"	$0.75	$ 50.00	$ 0.50	$ 96.00	$0.384	$ 170.00	$0.340	$ 314.00	$ 0.314
9/16"	$0.75	$ 50.00	$ 0.50	$ 96.00	$0.384	$ 170.00	$0.340	$ 314.00	$ 0.314
5/8"	$0.80	$ 67.00	$ 0.67	$ 129.00	$0.516	$ 228.00	$0.456	$ 421.00	$ 0.421
11/16"	$0.80	$ 67.00	$ 0.67	$ 129.00	$0.516	$ 228.00	$0.456	$ 421.00	$ 0.421
3/4"	$1.40	$118.00	$ 1.18	$ 226.00	$0.904	$ 400.00	$0.800	$ 740.00	$ 0.740
13/16"	$1.40	$118.00	$ 1.18	$ 226.00	$0.904	$ 400.00	$0.800	$ 740.00	$ 0.740
7/8"	$1.50	$123.00	$ 1.23	$ 234.00	$0.936	$ 414.00	$0.828	$ 766.00	$ 0.766
15/16"	$1.60	$136.00	$ 1.36	$ 260.00	$1.040	$ 459.00	$0.918	$ 850.00	$ 0.850
3/8" Z	$0.65	$ 52.00	$ 0.52	$ 98.00	$0.392	$ 173.00	$0.346	$ 321.00	$ 0.321
1/2" Z	$0.80	$ 62.00	$ 0.62	$ 116.00	$0.464	$ 207.00	$0.414	$ 382.00	$ 0.382
5/8" Z	$1.00	$ 81.00	$ 0.81	$ 157.00	$0.628	$ 277.00	$0.554	$ 513.00	$ 0.513

Note: These plugs are designed for drilled holes and must have a uniform circumference. Torched vent holes may require additional preparation with a larger drill or reamer.

Zinc Plugs (3/8"Z, 1/2"Z & 5/8"Z) are also available but not currently stocked at NAGC.

Larger (over 15/16") plug sizes are available on a made-to-order basis.

Destructive pressure vent holes
(for overlapping <u>seal welded</u> surfaces)

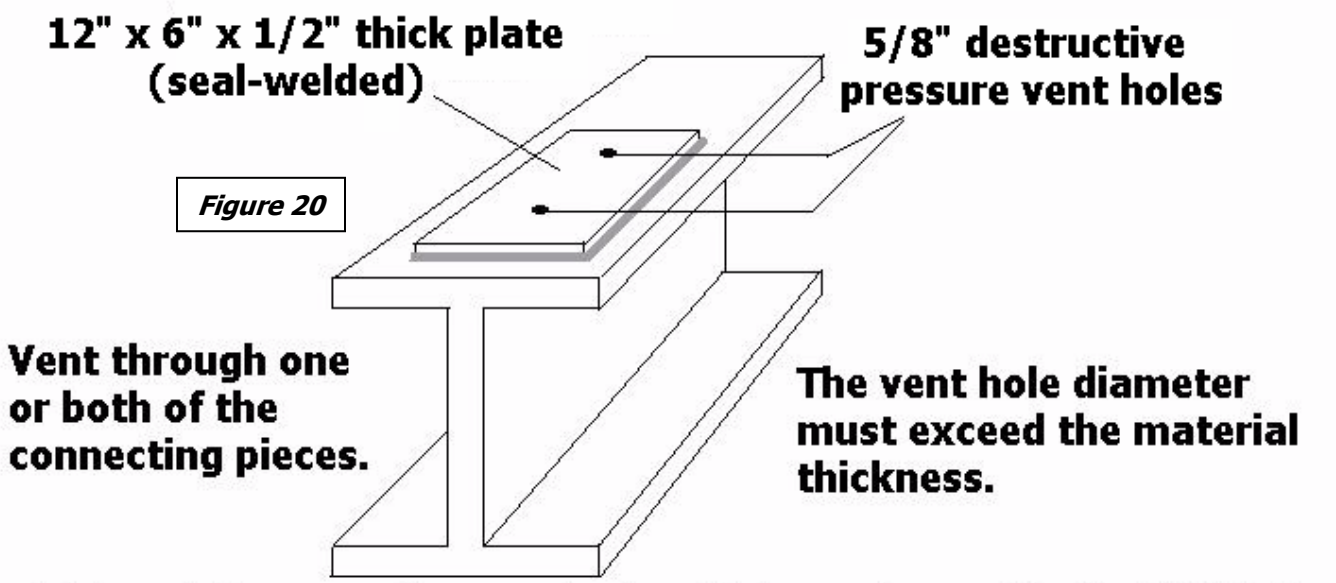
Due to the temperatures involved with the hot dip galvanizing process, overlapped surfaces that are seal welded can produce a buildup of destructive pressures, resulting in explosions, due to trapped air, moisture or a combination of the two.

This presents serious safety concerns for the galvanizer's kettle operators as well as the potential for severe damage to the fabrication or galvanizing equipment.

NAGC requires that all overlapped, seal-welded areas exceeding 16 square inches must be vented through one or both of the connecting pieces. A single vent hole is adequate up to 50 square inches.

Each additional 50 square inch area requires one additional vent hole. For example, 72 square inches (*figure 20*) requires 2 holes. The hole size must always exceed the thickness of the material with an absolute minimum of 3/8".

Figure 20



Total sealed area = 72 square inches: Hole requirement is 2 - 5/8" Holes

The 1st centrally located vent hole is required at 16 square inches of sealed surface area. The single hole is sufficient up to a 50 sq. in. area. A second equally spaced hole is required from 51 - 100 sq. inches. Each additional 50 sq. inches will require one additional hole all equally spaced over the total seal welded surface area.

North American Galvanizing Company

Take the shine off!
Ask for "Dull & Oil"

North American Galvanizing Company offers reduced reflectivity

Newly hot dip galvanized material is immersed in a specially formulated zinc phosphate treatment for a period of 3-6 minutes. Through this process, the shiny zinc surface is converted to a dull crystalline phosphate coating without affecting the corrosion resistant properties of the hot dip galvanized coating.

The zinc phosphate treatment is followed by a light application of oil in order to prevent the formation of zinc oxides (white rust). The oil used by North American Galvanizing to prevent zinc oxidation, is specifically designed to dry quickly, but it can under certain atmospheric conditions, remain wet for longer periods of time. In these circumstances the material is more susceptible to attracting dirt or other foreign airborne particles. This however, has no effect on the corrosion resistant properties of the dulled, galvanized material. The oil evaporates over time, leaving a normal, protective, weathered, galvanized coating.

Please be advised that North American Galvanizing Company cannot control the degree of reflectivity reduction on a given material as the steel composition is the primary determining factor in both the original color/luster of the hot dip galvanized coating, as well as how dark or dull of a coating the zinc phosphate treatment will achieve. In short, varying steel chemistries will reflect inconsistent results and thus our ability to achieve a specific darkness or dullness is limited at best.

This process currently available in Denver (only), is the same process that North American Galvanizing Company has provided to reduce reflectivity on hot dip galvanized coatings for transmission towers, substation structures, USDA Forest Service structures and the ski lift industry in Colorado, neighboring states and Canada for over 15 years.

Please contact North American Galvanizing for all your hot dip galvanizing and other corrosion protective coating requirements.

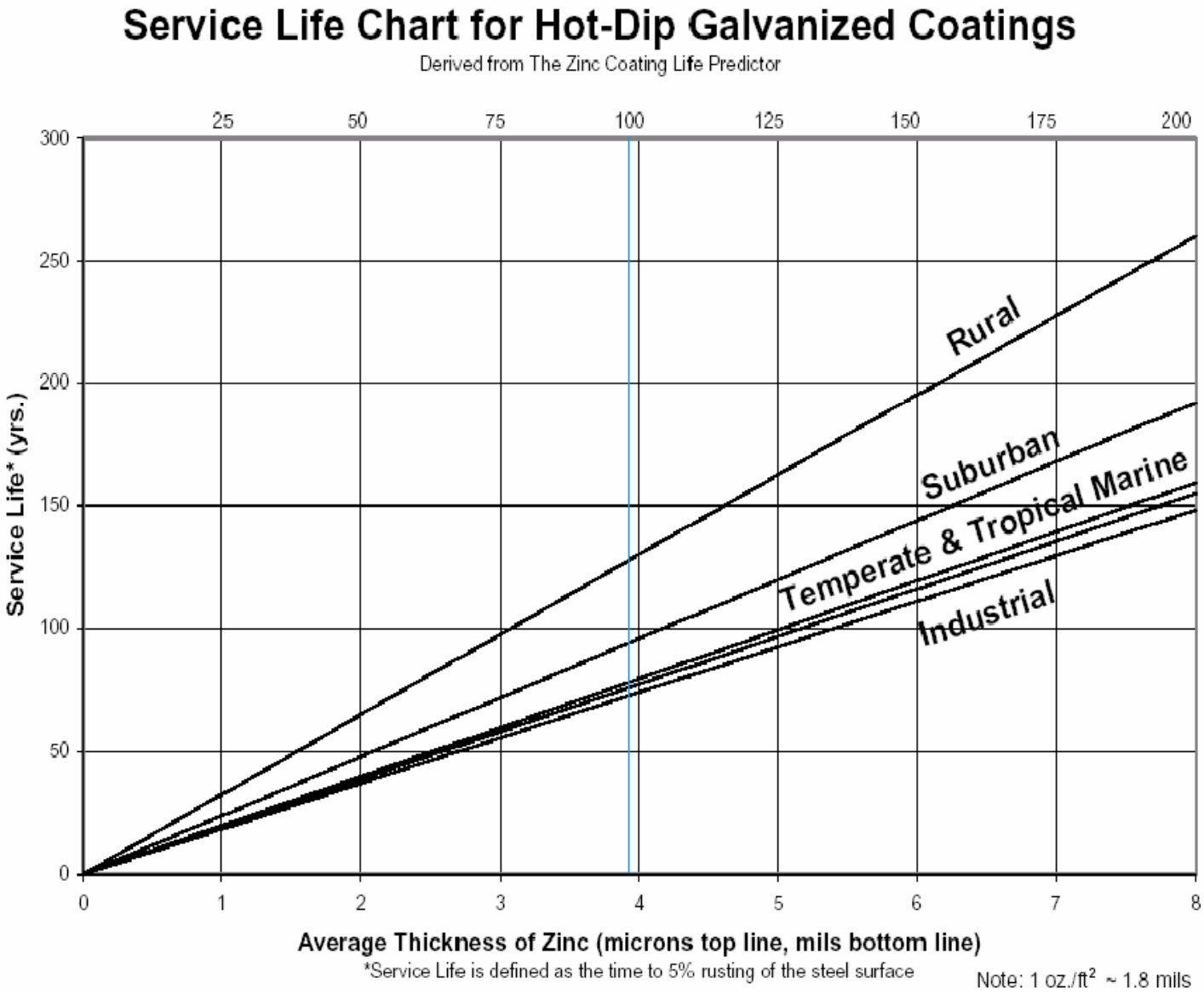
Other NAGC Plant Locations / Kettle Sizes (length, width, depth)

CANTON, OH	**HURST, TX (DFW)**	**HOUSTON, TX**	**KANSAS CITY, MO**	**LOUISVILLE, KY**
52'Lx6'4"Wx8'6"D & 16'Lx4'6"Wx5'6"D	42'L x 6'6"W x 7'6"D	62'L x 8'W x 10'D	30'L x 4'6"W x 5'6"D	42'L x 5'W x 6'D
PHONE: 330-477-4800	PHONE: 817-268-2414	PHONE: 832-467-3772	PHONE: 816-241-4300	PHONE: 502-367-6146
NASHVILLE, TN	**ST. LOUIS, MO**	**TULSA, OK #1**	**TULSA , OK #2**	**REINFORCING SVCS**
51'L x 6'5"W x 8'5"D	51'L x 7'3"W x 10'D	56'L x5'3"W x 7'D	43'L x 6'6"-4'6"(taper)W x -6'6"D	36'6"L x 4'2"W x 6'D
PHONE: 615-297-9581	PHONE: 314-993-1562	PHONE: 918-584-0303	PHONE:	PHONE: 918-379-0090

North American Galvanizing Company CORPORATE HEADQUARTERS: 5314 South Yale, Suite 1000, Tulsa, OK 74135, (918)488-9420, Fax: (918)488-8172

North American Galvanizing Company

New Service-Life Predictor Chart for Hot Dip Galvanized Steel



Note: 3.9 mils of zinc coating is the minimum average thickness for 1/4" structural steel per ASTM A123-01, Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron & Steel Products

Source: American Galvanizers Association - American Galvanizer Publication April 2002.

INFRASHIELD℠ TECHNICAL DATA

North American Galvanizing Company

POLYURETHANE PROTECTIVE LINING AND COATING

INFRASHIELD™ coating is a multi-part polymer coating application system designed to be applied in conjunction with hot dip galvanizing. INFRASHIELD™ coating application technology allows specialty designed polymer coatings to be applied to galvanized surfaces resulting in superior corrosion protection offered by combining cathodic protection with a non-conductive coating.

INFRASHIELD™ coating technology expands the range of use and effectiveness for a variety of dependable polymer coatings. The fast cure time and one coat application allow for consistent coating quality with virtually unlimited film build. These products offer reliable flexibility and are impact, chemical and abrasion resistant. Typical uses can range from direct soil contact structural components, fresh water and waste water treatment and transportation, hazardous waste storage, chemical processing, power generation and many other applications that have unique corrosion issues.

TECHNICAL INFORMATION

PROPERTY	TEST DESCRIPTION	RESULTS
Application Temperatures	N/A	-40° C(-40° F) to 65° C(150° F)
Curing Time Before Handling	@ 20° C/70° F	10 - 120 minutes
Curing Time Before Immersion	@ 20° C/70° F	48 hours
Ultimate Cure	@ 20° C/70° F	2 - 5 days
Recoat Time	@ 20° C/70° F	1 to 6 hours
Solids Content	ASTM D-1259	99+/-1%
Abrasion Resistance	ASTM D-4060 (Taper CS-17)	80 mg @ 1 kg per 1000 cycles
Permeability	ASTM E-968 (15 mils)	0.002 perm inches
Adhesion to steel	ASTM D-4541	(SSPC 5) Greater than 1500 p.s.i.
Hardness	ASTM D-2240	Shore D 70+/-5
Flexibility	ASTM D-412	180° over 1" mandrel
Resistance to Cathodic	ASTM G-8 -72(STP, 28 days)	Excellent, less than 10 mm radius
Disbondment	ASTM G-8- 72(650 C,28 days)	Excellent, 20 mm radius.
Impact Resistance	ASTM G-2794 (20 mils)	40 in. lbs.
Chemical Resistance	ASTM D-543	Excellent
Ultraviolet Resistance	ASTM G-53	Excellent * Consult Company
Service Temperature	ASTM D-870, ASTM D-2485	-40° C(-40° F) to 90° C(195° F)
Colors	N/A	Consult Company

NORTH AMERICAN GALVANIZING LOCATIONS

Denver, CO
303.288.6631

Houston, TX
832.467.3772

D/FW, Texas
817.268.2414

Louisville, KN
502.367.6146

Nashville, TN
615.297.9581

St. Louis, MO
314.993.1562

Kansas City, MO
816.241.4300

Tulsa, OK
918.584.0304

www.nagalv.com

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North American Galvanizing Company

Profile your galvanizing without removing protection!

Ask for chemical etch, for secondary coatings!

North American Galvanizing Company offers chemical etching for secondary coatings

Today's budgets just don't seem to include the critical maintenance dollars needed to maintain our existing (painted only) exposed steel structures. Secondary coatings over hot dip galvanizing are becoming much more popular as life cycle cost calculations on exposed steel structures are demanding the corrosion protection advantages of hot dip galvanizing, along with color coat options to meet aesthetic preferences.

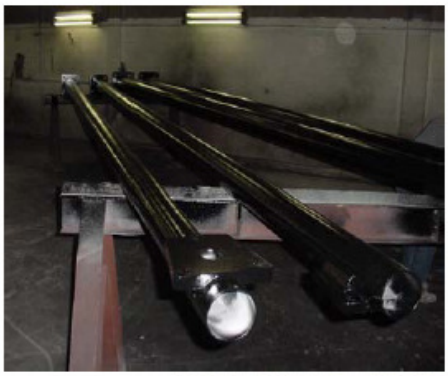
Hot Dip Galvanizing provides both barrier and cathodic protection to all internal as well as external surfaces, slowly sacrificing itself to protect the underlying steel, providing protection that can well exceed 100 years (depending on environment and application conditions).

Sweep blasting of the galvanized coating does provide an adequate surface for secondary coatings, however, at the expense of precious coating thickness, thus reducing the total service life of the galvanized coating.

Now you can have it all, without compromising the galvanized protection. North American Galvanizing Company provides a chemically profiled surface, without affecting the corrosion resistant properties, nor the thickness of the original hot dip galvanized coating.

At NAGC Denver, newly hot dip galvanized material is immersed (see above photos) in a specially formulated, heated zinc phosphate treatment for a period of 3-6 minutes. As described in ASTM D6386 *Standard practice for preparation of zinc -(hot dip galvanized) coated surfaces for painting,* through this chemical process, the smooth zinc surface is converted to a dull crystalline phosphate coating.

The resulting anchor surface profile typically exceeds 2.0 mils, providing an excellent surface for secondary coating adhesion as was performed on the following structures.


Important: As described in ASTM D6386, the zinc phosphate treated material must be washed with clean water and allowed to dry completely prior to applying the secondary coating.

Always select secondary coatings that are compatible with hot dip galvanizing.

Due to newly galvanized coatings being in a constant state of change, application of secondary coatings should take place within 48-72 hours (Colorado environment) from the time the material is chemically etched and before the formation of zinc oxides. Other environments may require a tighter timeline.

This process, currently available in Denver (only), is the same process that North American Galvanizing Company has provided for 15 years to effectively profile (etch) hot dip galvanized surfaces, in preparation for secondary coatings or systems. Please contact North American Galvanizing for all your hot dip galvanizing and other corrosion protective coating requirements.

Other NAGC Plant Locations / Kettle Sizes (length, width, depth)

CANTON, OH	**HURST, TX (DFW)**	**HOUSTON, TX**	**KANSAS CITY, MO**	**LOUISVILLE, KY**
52'Lx6'4"Wx8'6"D & 16'Lx4'6"Wx5'6"D	42"L x 6'6"W x 7'6"D	62'L x 8'W x 10'D	30'L x 4'6"W x 5'6"D	42'L x 5'W x 6'D
PHONE: 330-477-4800	PHONE: 817-268-2414	PHONE: 832-467-3772	PHONE: 816-241-4300	PHONE: 502-367-6146
NASHVILLE, TN	**ST. LOUIS, MO**	**TULSA, OK #1**	**TULSA , OK #2**	**REINFORCING SVCS**
51'L x 6'5"W x 8'5"D	51'L x 7'3"W x 10'D	56'L x5'3"W x 7'D	43'L x 6'6"-4'6"(taper)W x -6'6"D	36'6"L x 4'2"W x 6'D
PHONE: 615-297-9581	PHONE: 314-993-1562	PHONE: 918-584-0303	PHONE:	PHONE: 918-379-0090

North American Galvanizing Company CORPORATE HEADQUARTERS: 5314 South Yale, Suite 1000, Tulsa, OK 74135, (918)488-9420, Fax: (918)488-8172

NAGC approved marking pen

Pen # 83420 ONLY

North American Galvanizing Company

4400 East 61st Avenue Commerce City, CO 80022
Phone: 303-288-6631 Fax: 303-288-0726

"The best results aren't by accident"

Free 2-hour Hot Dip Galvanizing Seminar

The corrosion problem
The benefits of Hot Dip Galvanizing
How your material is processed
HDG related ASTM specifications

Fabrication design for hot dip galvanizing

Relation of fabrication dimension/configuration to kettle size
Steel selection – composition affects results
Mixed material fabrications
Heat distortion & warpage
Welding practices prior to galvanizing
Proven venting & draining designs
Duplex systems – secondary coatings over galvanizing
Preventing galvanizing on specific areas
Damaged galvanizing repair options
Shipping & storage of galvanized material

This information can save time, money and improve your galvanized product!!

Contact North American Galvanizing Company at 303-288-6631 to sign up or to schedule a seminar at your location.

The complete seminar w/question & answer time runs about 2-hours but can be streamlined to your available time.

NAGC-Commerce City also provides a monthly seminar w/plant tour. The seminar/tour runs 2-1/2 hours. Sign up in advance as seating is limited. Please wear old clothes/shoes and bring a hard hat and safety glasses or a hard hat and safety glasses will be provided.