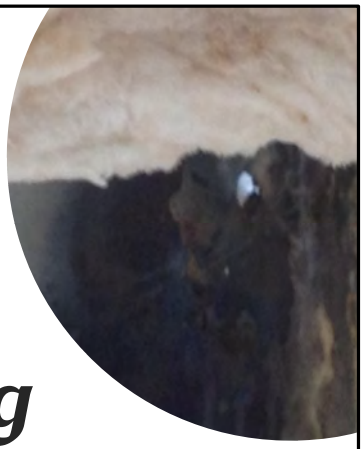


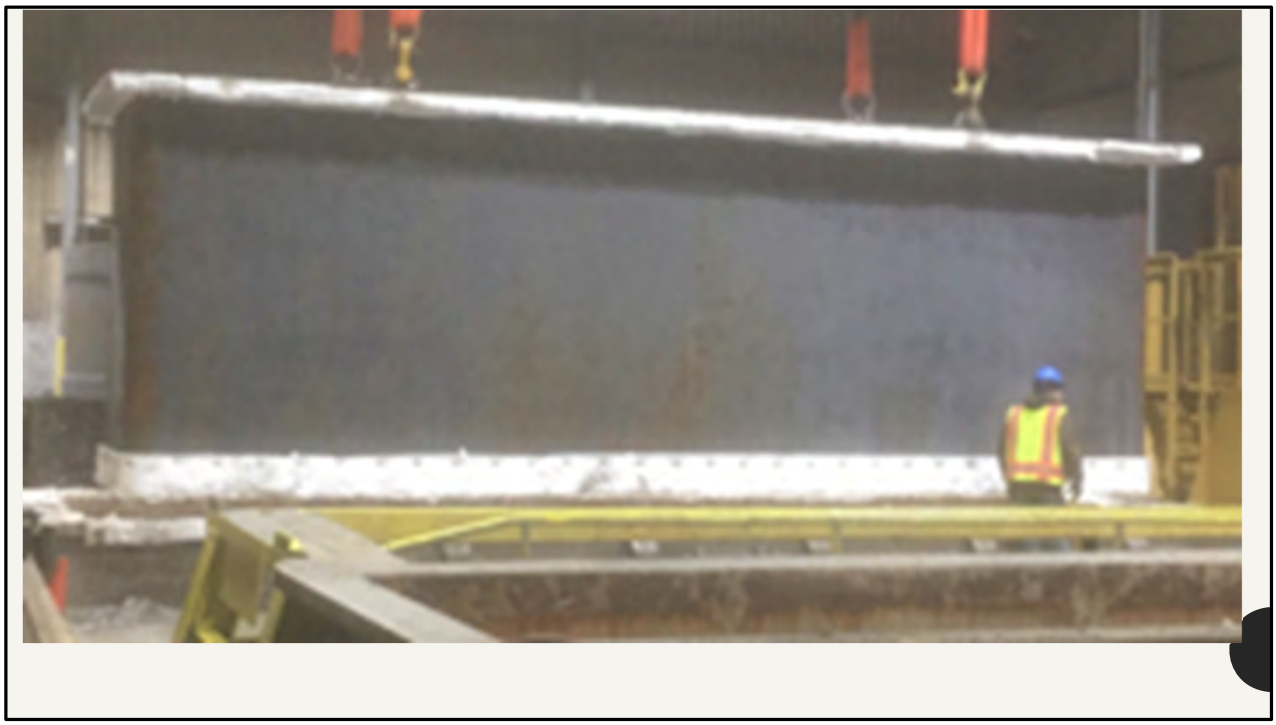
Galvanizing Kettle Lessons Learned

1. **Share V&S experiences and lessons we have learned.**
2. **We need to grow the industry helping each other by sharing our knowledge.**
3. **We are hoping by us opening up and sharing some sensitive information will help break down some of these barriers of not communicating hard lessons each of us has learned.**
4. **We will show some mistakes we made and bad practices we had.**
5. **Repairs that were made to get kettles back in operation.**
6. **Process changes and controls that were made to minimize the risk of reoccurrence.**
7. **Emergency equipment and supplies we need to have on hand.**
8. **Go over the drossing process and best practices.**
9. **Go over kettle changes from pumping out to pump back and equipment used.**

Presentation overview

- We are here to share what works for V&S
- We are not saying this the right way or the only way
- Our large kettles are flat flame so there will be some differences with high velocity furnaces.
- We have no enclosures around our kettles, so we have full access.
- There is plenty of room on either side of the kettle to drive large lift trucks around.
- We have at least two bridge cranes on each side of our plants with two, 5-to-10-ton hoists on each bridge.

Quick overview of how V&S plants are set up.



Picture shows insulated areas of kettle in the fire chamber.
Two layers of 2” wool under lip in the ash build up area and one 2” thick layer 12” wide around the bottom of the kettle in dross area.
2” bottom plate allows for 10” of dross before you get above insulation creating a dangerous condition of overheating walls.

Terrible bath level control and ash buildup cleaning practices.
These pictures were at kettle change and picture on the right was when we were cutting up after some corner buildup was removed.
(point out) Chipping that was done to cut kettle up.
Ash is an insulator, Air is an insulator, Dross is an insulator and Zinc is a conductor.

Outside view of leak
Tear in the corner of kettle from a piece of steel getting galvanized caused the leak
Drilled some holes to determine steel thickness for welding

Repair used was a radius corner patch we had on hand in our emergency leak container.
Very minimal production loss. Scooped a few pans out while identifying where leak area was.
Got below leak, started racking using longer wires.
Galvanized at lower level for the next shift while getting ready for this repair.
Kettle was 7 plus years, so we scheduled for kettle change later that year.

Long Wall ash build up after leak.
Corrosion rate of the steel that is being heated to over 1000 deg F can be up to 1000 times faster.

This is what you will have happen if these poor practices continue.

Sidewall washout leak. Repaired with sand box insulated and this is two years later when kettle is being changed.
After being there for two years and no weld repair when we cut box off there was a nickel sized piece of zinc between sand and the hole

Second picture of sidewall sandbox.
Leak was right at a burner so there was white smoke from the leaking zinc spraying on the burner.

Washout 8” from top of 6 year old kettle.
If you can see erosion started just below the 6 inch point.

Outside to show just under the 4 inches of wool under top lip.
Tried the sharpened bolt hammered into hole, I have been told galvanizers do this but my experience never enough steel at leak point.’

This kettle was repaired welding wash line back up.
Crusted kettle, fabricated support platform, laid wool on platform, sheet plywood on wool.
Need to keep wetting wool to keep plywood from smoking and have plenty of ventilation.

Cooking Out Zinc With Torch

Hours Of Weld Repair

Very long process to repair.
Grind and cook out all zinc to clean steel entire repair area.
Weld back up pass after pass.

Same kettle after ultrasound identified very thin wall in the same area of the kettle. Burner turned until new kettle installe
Testing showed large area several feet down all ½ inch thick.
Identified as cracked burner block creating overheating in this area.
Worried about catastrophic failure so we fabricated this sandbox to help if a leak and keep this area cool.

Another picture.
Wool will act as a gasket to keep sand in box..
The reason for the shape is it had to go around a tank support.

Fabrication was hung in the area we wanted, and we installed anchors to push against kettle since there was no way to weld down low
Welded a couple small welds at the top to anchor to the kettle.

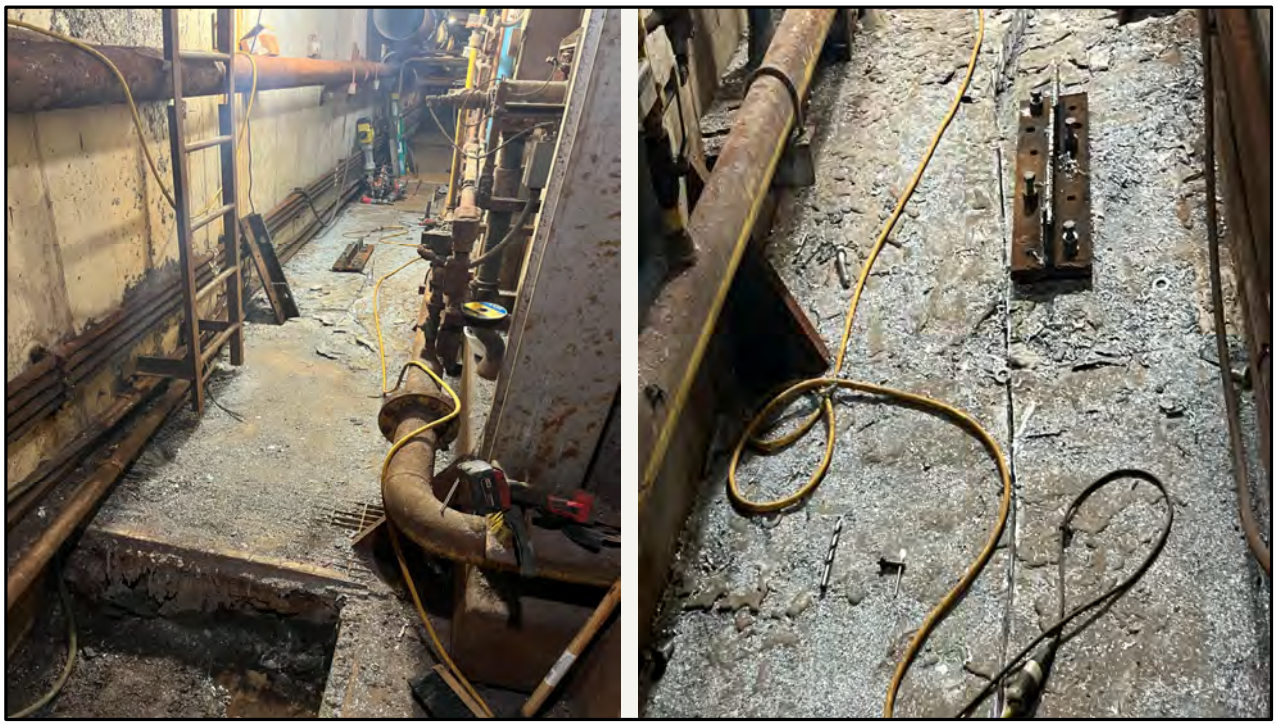
We then filled with sand.
Started scheduling for this first kettle change of our largest kettle 56’Lx7’2”Wx10’8”D at 7 ½ years kettle life
Only problem with repair after weekends with two days shutdown some frozen zinc occurred on wall in this area.
Once production started and we went to high fire and zinc started really moving some chunks of zinc floated for the first few racks as they melted off wall

Kettle damage and leak determined to be a combination of excess dross and burner issue.

Dross build up over long periods of time and not cleaning where wall meets the floor good.
Use depth indicator when checking for dross so you know where the bottom is. You can also have this marked somehow on dross shovel to tell you are on the bottom of your kettle.

Another corner leak from not keeping walls clean.

Inside view after leak.



Don’t be this guy having to figure out how to clean your kettle pit up.

Hours of work cutting and jacking to remove this zinc
Easiest way we found to lift zinc is drill holes and use long lag bolts ¾” to 1” to anchor lifting points.
We had lifting anchors wired under grating, but they weren’t much help with zinc over the grating.

Removing zinc from another kettle pit from a leak.
Point out and talk about leak port.

Clean leak port with new lead shield and new flame rod used to complete circuit to detect leak.
Shield holds molten zinc back touching the flame rod setting alarm off.
Shield will then burn through allowing zinc to drain into revisors around the kettle.

V&S GALVANIZING KETTLE LEAK STORAGE CONTAINER CHECKLIST

Items	Notes	Check Below
200 Clean Drums	Drums Should Be Blasted Or Incinerated (No Paint)	
Zinc Pump And Electrical Control Panel	All Plants Will Have A Zinc Pump	
Pump Pipes And All Fittings Needed For Reaching Pans	Pipes Should Be Sized For Your Kettle	
Radius Corner Patches For Outside Hole Repair	Being Made By Columbiana Specific To Plant Kettle	
6 Pcs.Sheered 1/4" Plate 8"X24"	Material For Sandbox Fabrication	
100# 6012 Welding Rod - 50# 1/8" & 50# 5/32" Rod	Keep Dry And Sealed	
2 Pcs. 4'X8'X1/2" Steel Plate	For Inside Kettle Welding Platform	
3 Pcs. 4"x3/8" Angle Full Lengths	To Fabricate And Support Platform	
3 Pcs. 1 1/2" all thread 6' long with 12 heavy hex nuts	To push box against kettle if necessary	
2 Pcs. 4'X8"X3/4" Plywood	Used To Lay On To Work In Kettle	
4 Boxes Fiber Wool 1" Thick (Kettle Insulation)	Used To Insulate Repairs And Protect Workers	
4 Boxes Fiber Wool 2" Thick (Kettle Insulation)	Used To Insulate Repairs And Protect Workers	
200' Water Hose Or Length Needed To Reach All Kettle	Water Used To Stop Leak While Lowering Zinc Level	
Two Good Hose End Spray Nozzles	Water Control To Direct On Leak For Freezing Zinc	
40 Bags, Supersack or Drums Sand Approx.. 2,000#	To Fill Sandbox Fabricated At Leak (Keep Dry)	
Silver High Temp PPE For Minimum 4 Employees	Lab coats Work Nice Instead Of Two-Piece Suits	
Two Large Rosebud Setups (Acetylene Or Propylene)	Torch, Hose And Regulators (No Cutting Torches)	
Two Good High Velocity Fans	For Temperature And Fume Control When Welding	
Normal Kettle PPE For 6 Employees	Welding Gloves, Shields And Spentex Coveralls/Lab coats	
Welding Fire Blanket	Should be 6'x6' or larger	
Maintenance Equipment Not In Container		
Good Welder That Works Properly	If Welder Is Not Working Properly Let's Look At Upgrading	
Needle Gun For Cleaning Welds	Can Be Electric Or Pneumatic	
Plants Should Have A Minimum Compressed Gas Supply	Should Always Be Two Full Tanks Of Fuel And Oxygen	

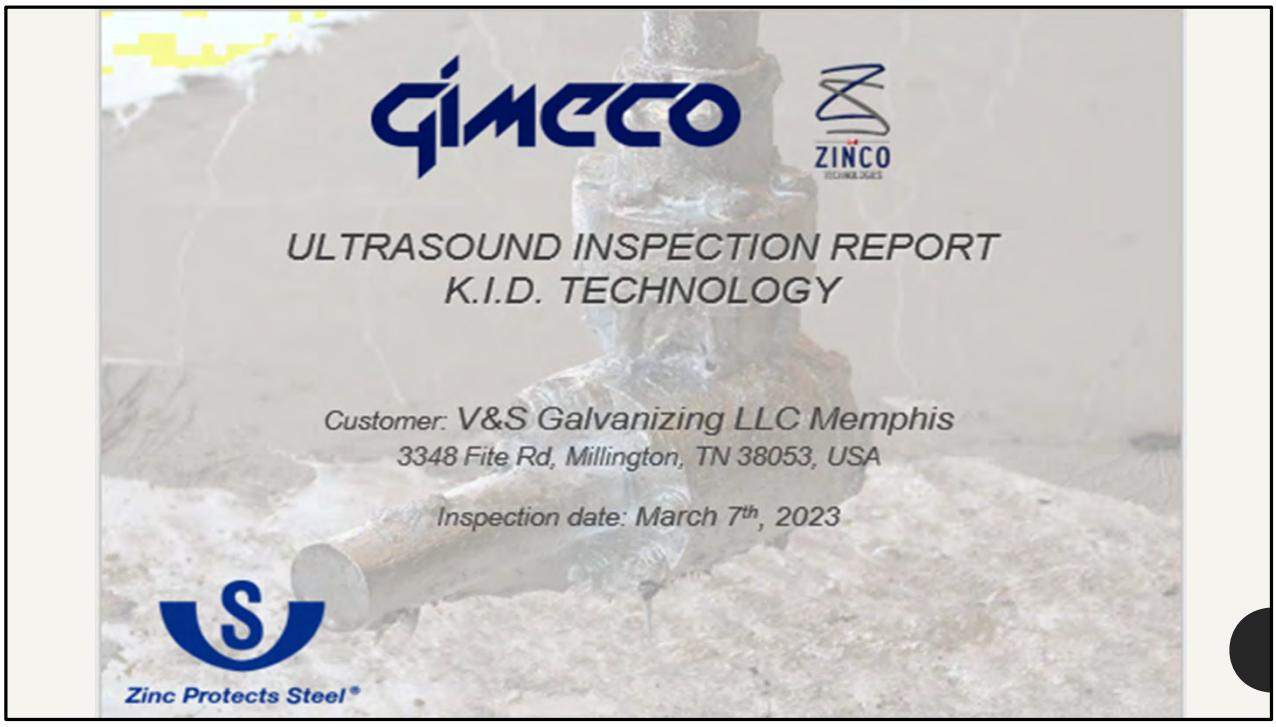
This list should be secured and always available in container. Not where you go and grab supplies when needed.
This is in addition to 25 zinc pans that each plant owns.

Zinc scoops stored in an area of kettle along with zinc pans for quick access to kettle.
Explain size and shape.

Periodic lowering zinc level to inspect walls and training for different employees who might respond to an emergency.

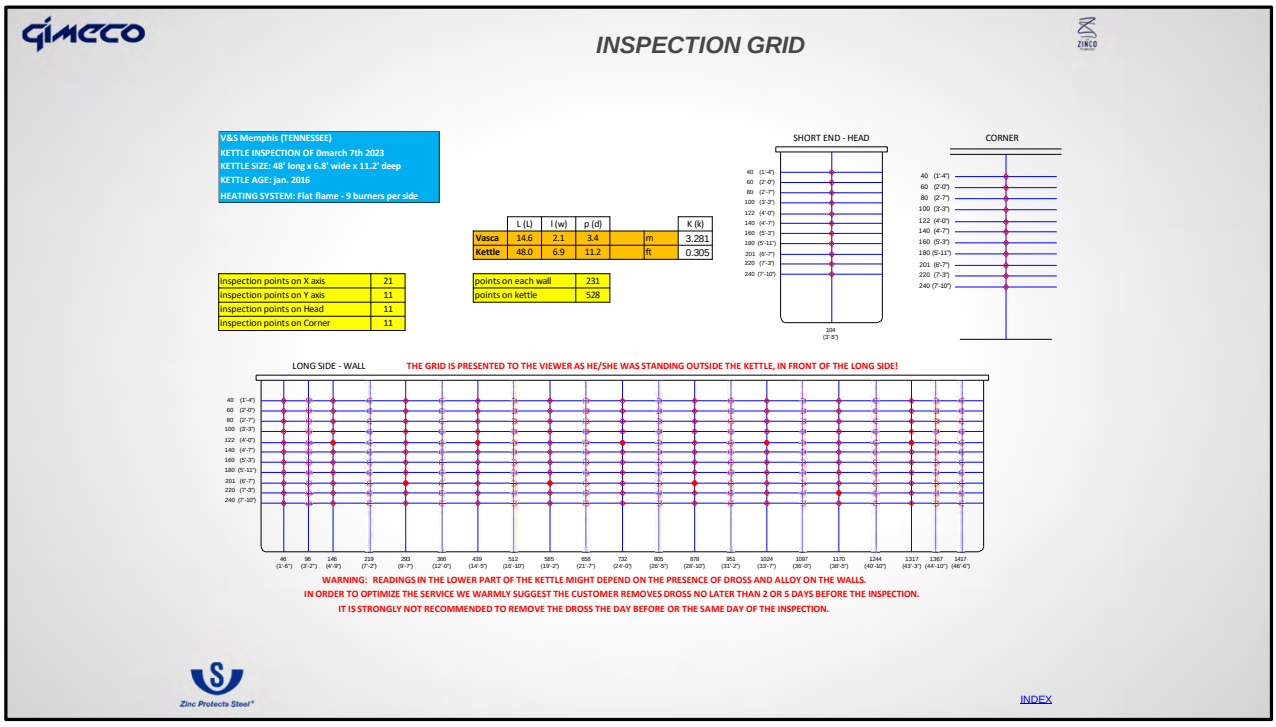
Video of a new kettle employee being trained using the scoop to fill a zinc pan.

After lowering zinc 10-12” take some pictures and inspect walls for wash areas.

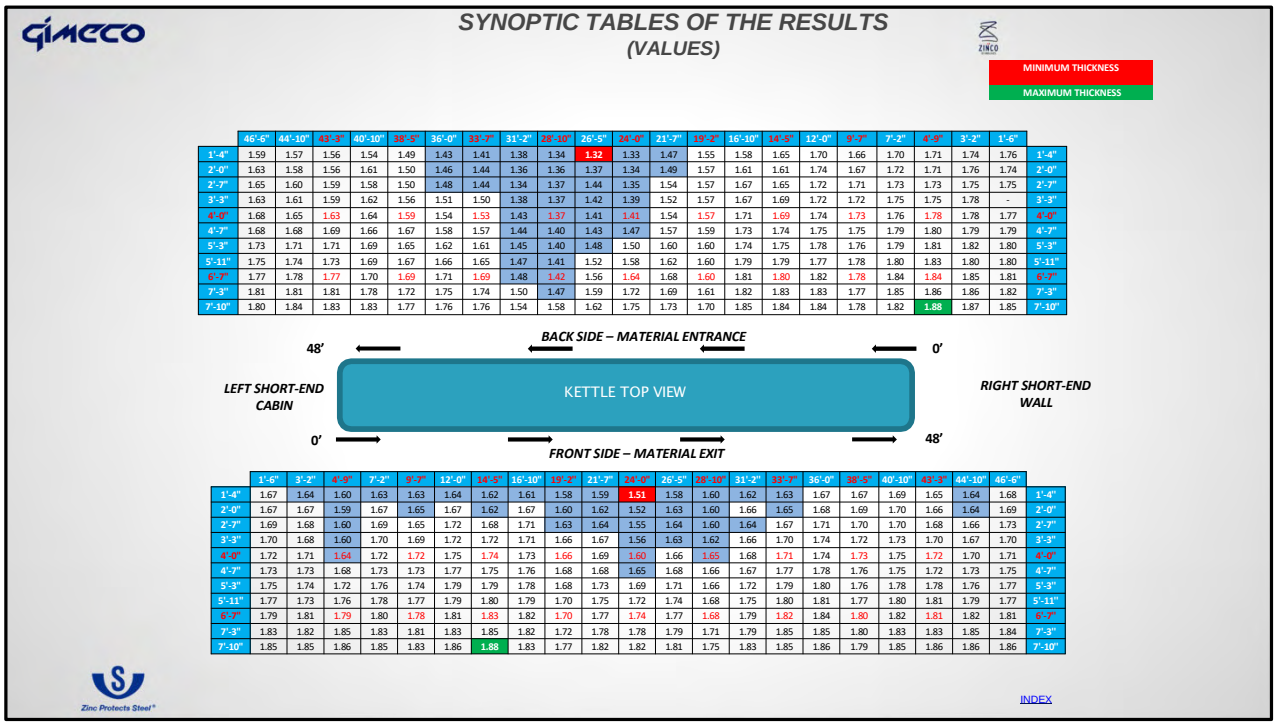


Ultrasound testing of kettle walls.
Frequency varies on time in service.

High temp probe Vendor supplied that is bolted onto plant owned steel fixture.
Plants receive a material list to purchase, and Zinco will assist in fabrication.
This fixture will be used for all inspections at this plant.
Not much to it so you can choose to move around if there are multiple plant or make one for each plant.



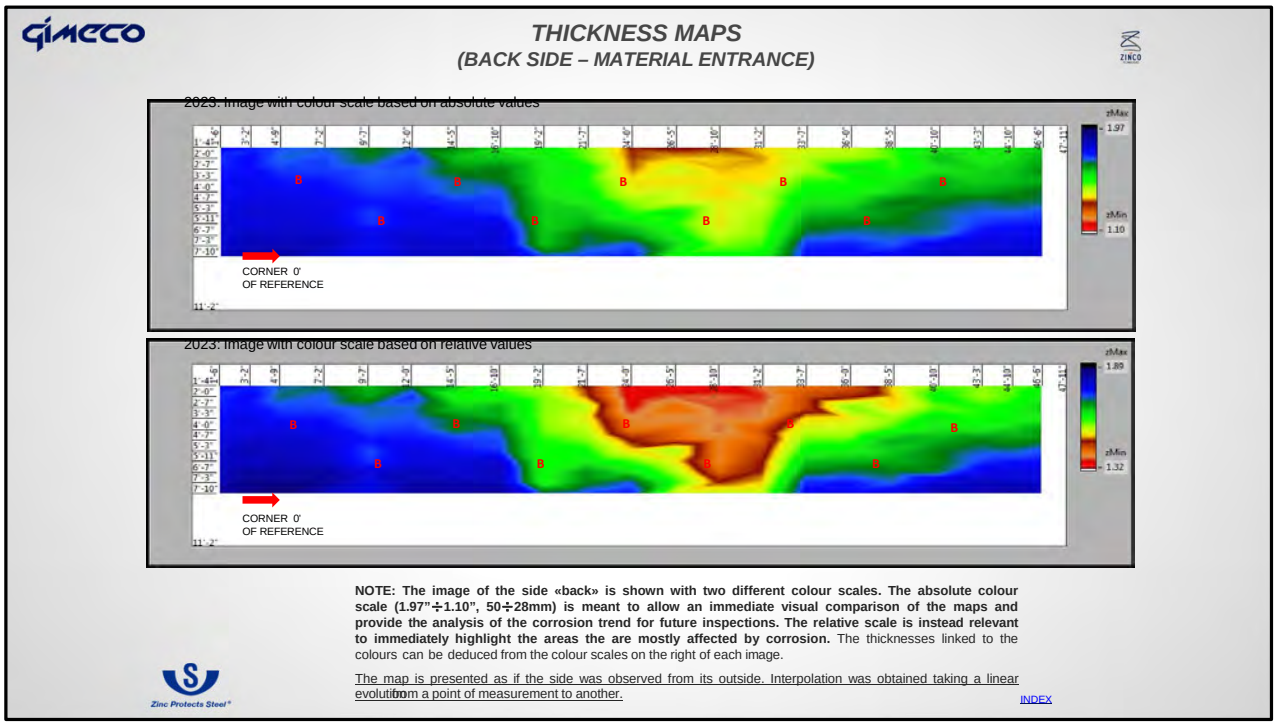
Inspection grid pre-determined through sharing dimensions and burner locations prior to inspection.
528 inspection points on this 49 foot kettle.



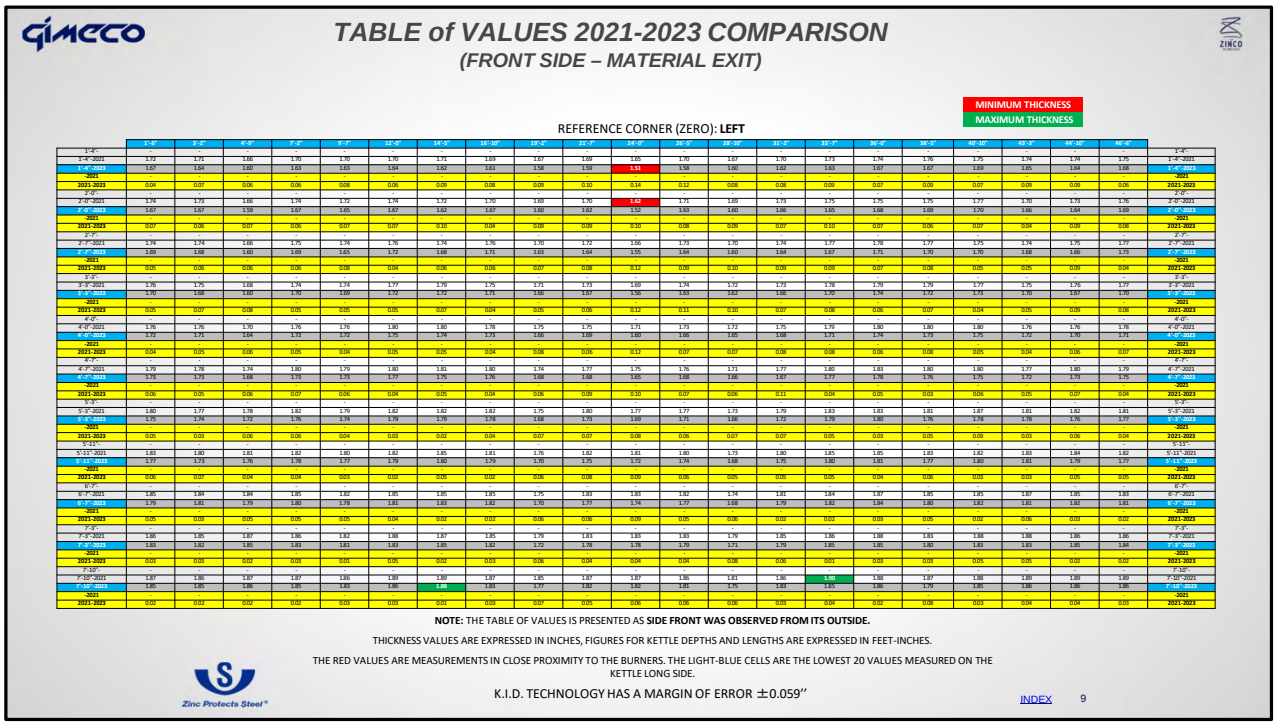
	46'-6"	44'-10"	43'-3"	40'-10"	38'-5"	36'-0"	33'-7"	31'-2"	28'-10"	26'-5"	24'-0"	21'-7"	19'-2"	16'-10"	14'-5"	12'-0"	9'-7"	7'-2"	4'-9"	3'-2"	1'-6"	
1'-4"	1.59	1.57	1.56	1.54	1.49	1.43	1.41	1.38	1.34	1.32	1.33	1.47	1.55	1.58	1.65	1.70	1.66	1.70	1.71	1.74	1.76	1'-4"
2'-0"	1.63	1.58	1.56	1.61	1.50	1.46	1.44	1.36	1.36	1.37	1.34	1.49	1.57	1.61	1.61	1.74	1.67	1.72	1.71	1.76	1.74	2'-0"
2'-7"	1.65	1.60	1.59	1.58	1.50	1.48	1.44	1.34	1.37	1.44	1.35	1.54	1.57	1.67	1.65	1.72	1.71	1.73	1.73	1.75	1.75	2'-7"
3'-3"	1.63	1.61	1.59	1.62	1.56	1.51	1.50	1.38	1.37	1.42	1.39	1.52	1.57	1.67	1.69	1.72	1.72	1.75	1.75	1.78	-	3'-3"
4'-0"	1.68	1.65	1.63	1.64	1.59	1.54	1.53	1.43	1.37	1.41	1.41	1.54	1.57	1.71	1.69	1.74	1.73	1.76	1.78	1.78	1.77	4'-0"
4'-7"	1.68	1.68	1.69	1.66	1.67	1.58	1.57	1.44	1.40	1.43	1.47	1.57	1.59	1.73	1.74	1.75	1.75	1.79	1.80	1.79	1.79	4'-7"
5'-3"	1.73	1.71	1.71	1.69	1.65	1.62	1.61	1.45	1.40	1.48	1.50	1.60	1.60	1.74	1.75	1.78	1.76	1.79	1.81	1.82	1.80	5'-3"
5'-11"	1.75	1.74	1.73	1.69	1.67	1.66	1.65	1.47	1.41	1.52	1.58	1.62	1.60	1.79	1.79	1.77	1.78	1.80	1.83	1.80	1.80	5'-11"
6'-7"	1.77	1.78	1.77	1.70	1.69	1.71	1.69	1.48	1.42	1.56	1.64	1.68	1.60	1.81	1.80	1.82	1.78	1.84	1.84	1.85	1.81	6'-7"
7'-3"	1.81	1.81	1.81	1.78	1.72	1.75	1.74	1.50	1.47	1.59	1.72	1.69	1.61	1.82	1.83	1.83	1.77	1.85	1.86	1.86	1.82	7'-3"
7'-10"	1.80	1.84	1.83	1.83	1.77	1.76	1.76	1.54	1.58	1.62	1.75	1.73	1.70	1.85	1.84	1.84	1.78	1.82	1.88	1.87	1.85	7'-10"

	1'-6"	3'-2"	4'-9"	7'-2"	9'-7"	12'-0"	14'-5"	16'-10"	19'-2"	21'-7"	24'-0"	26'-5"	28'-10"	31'-2"	33'-7"	36'-0"	38'-5"	40'-10"	43'-3"	44'-10"	46'-6"	
1'-4"	1.67	1.64	1.60	1.63	1.63	1.64	1.62	1.61	1.58	1.59	1.51	1.58	1.60	1.62	1.63	1.67	1.67	1.69	1.65	1.64	1.68	1'-4"
2'-0"	1.67	1.67	1.59	1.67	1.65	1.67	1.62	1.67	1.60	1.62	1.52	1.63	1.60	1.66	1.65	1.68	1.69	1.70	1.66	1.64	1.69	2'-0"
2'-7"	1.69	1.68	1.60	1.69	1.65	1.72	1.68	1.71	1.63	1.64	1.55	1.64	1.60	1.64	1.67	1.71	1.70	1.70	1.68	1.66	1.73	2'-7"
3'-3"	1.70	1.68	1.60	1.70	1.69	1.72	1.72	1.71	1.66	1.67	1.56	1.63	1.62	1.66	1.70	1.74	1.72	1.73	1.70	1.67	1.70	3'-3"
4'-0"	1.72	1.71	1.64	1.72	1.72	1.75	1.74	1.73	1.66	1.69	1.60	1.66	1.65	1.68	1.71	1.74	1.73	1.75	1.72	1.70	1.71	4'-0"
4'-7"	1.73	1.73	1.68	1.73	1.73	1.77	1.75	1.76	1.68	1.68	1.65	1.68	1.66	1.67	1.77	1.78	1.76	1.75	1.72	1.73	1.75	4'-7"
5'-3"	1.75	1.74	1.72	1.76	1.74	1.79	1.79	1.78	1.68	1.73	1.69	1.71	1.66	1.72	1.79	1.80	1.76	1.78	1.78	1.76	1.77	5'-3"
5'-11"	1.77	1.73	1.76	1.78	1.77	1.79	1.80	1.79	1.70	1.75	1.72	1.74	1.68	1.75	1.80	1.81	1.77	1.80	1.81	1.79	1.77	5'-11"
6'-7"	1.79	1.81	1.79	1.80	1.78	1.81	1.83	1.82	1.70	1.77	1.74	1.77	1.68	1.79	1.82	1.84	1.80	1.82	1.81	1.82	1.81	6'-7"
7'-3"	1.83	1.82	1.85	1.83	1.81	1.83	1.85	1.82	1.72	1.78	1.78	1.79	1.71	1.79	1.85	1.85	1.80	1.83	1.83	1.85	1.84	7'-3"
7'-10"	1.85	1.85	1.86	1.85	1.83	1.86	1.88	1.83	1.77	1.82	1.82	1.81	1.75	1.83	1.85	1.86	1.79	1.85	1.86	1.86	1.86	7'-10"

List of all the readings front and back.



Images of color scales using absolute and relative values making it easy to see trouble areas.



gimecco

TABLE of VALUES 2021-2023 COMPARISON

(FRONT SIDE – MATERIAL EXIT)

ZINCO

MINIMUM THICKNESS

MAXIMUM THICKNESS

REFERENCE CORNER (ZERO): **LEFT**

	1'-6"	3'-4"	4'-9"	7'-3"	9'-7"	12'-0"	14'-5"	16'-10"	19'-2"	21'-7"	24'-0"	26'-5"	28'-10"	31'-2"	33'-7"	36'-0"	38'-5"	40'-10"	43'-3"	44'-10"	46'-6"	
1'-4"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1'-4"-
1'-4"-2021	1.72	1.71	1.66	1.70	1.70	1.70	1.71	1.69	1.67	1.69	1.65	1.70	1.67	1.70	1.73	1.74	1.76	1.75	1.74	1.74	1.75	1'-4"-2021
1'-4"-2023	1.67	1.64	1.60	1.63	1.63	1.64	1.62	1.61	1.58	1.59	1.51	1.58	1.60	1.62	1.63	1.67	1.67	1.69	1.65	1.64	1.68	1'-4"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.04	0.07	0.06	0.06	0.08	0.06	0.09	0.08	0.09	0.10	0.14	0.12	0.08	0.08	0.09	0.07	0.09	0.07	0.09	0.09	0.06	2021-2023
2'-0"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2'-0"-
2'-0"-2021	1.74	1.73	1.66	1.74	1.72	1.74	1.72	1.70	1.69	1.70	1.62	1.71	1.69	1.73	1.75	1.75	1.75	1.77	1.70	1.73	1.76	2'-0"-2021
2'-0"-2023	1.67	1.67	1.59	1.67	1.65	1.67	1.62	1.67	1.60	1.62	1.52	1.63	1.60	1.66	1.65	1.68	1.69	1.70	1.66	1.64	1.69	2'-0"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.07	0.06	0.07	0.06	0.07	0.07	0.10	0.04	0.09	0.09	0.10	0.08	0.09	0.07	0.10	0.07	0.06	0.07	0.04	0.09	0.08	2021-2023
2'-7"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2'-7"-
2'-7"-2021	1.74	1.74	1.66	1.75	1.74	1.76	1.74	1.76	1.70	1.72	1.66	1.73	1.70	1.74	1.77	1.78	1.77	1.75	1.74	1.75	1.77	2'-7"-2021
2'-7"-2023	1.69	1.68	1.60	1.69	1.65	1.72	1.68	1.71	1.63	1.64	1.55	1.64	1.60	1.64	1.67	1.71	1.70	1.70	1.68	1.66	1.73	2'-7"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.05	0.06	0.06	0.06	0.08	0.04	0.06	0.08	0.07	0.08	0.12	0.09	0.10	0.09	0.09	0.07	0.08	0.05	0.05	0.09	0.04	2021-2023
3'-3"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3'-3"-
3'-3"-2021	1.76	1.75	1.68	1.74	1.74	1.77	1.79	1.75	1.71	1.73	1.69	1.74	1.72	1.73	1.78	1.79	1.79	1.77	1.75	1.76	1.77	3'-3"-2021
3'-3"-2023	1.70	1.68	1.60	1.70	1.69	1.72	1.72	1.71	1.66	1.67	1.56	1.63	1.62	1.66	1.70	1.74	1.72	1.73	1.70	1.67	1.70	3'-3"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.05	0.07	0.08	0.05	0.05	0.05	0.07	0.04	0.05	0.06	0.12	0.11	0.10	0.07	0.08	0.06	0.07	0.04	0.05	0.09	0.08	2021-2023
4'-0"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4'-0"-
4'-0"-2021	1.76	1.76	1.70	1.76	1.76	1.80	1.80	1.78	1.75	1.75	1.71	1.73	1.72	1.75	1.79	1.80	1.80	1.80	1.76	1.76	1.78	4'-0"-2021
4'-0"-2023	1.72	1.71	1.64	1.72	1.72	1.75	1.74	1.73	1.66	1.69	1.60	1.66	1.65	1.68	1.71	1.74	1.73	1.75	1.72	1.70	1.71	4'-0"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.04	0.05	0.06	0.05	0.04	0.05	0.05	0.04	0.08	0.06	0.12	0.07	0.07	0.08	0.08	0.06	0.08	0.05	0.04	0.06	0.07	2021-2023
4'-7"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4'-7"-
4'-7"-2021	1.79	1.78	1.74	1.80	1.79	1.80	1.81	1.80	1.74	1.77	1.75	1.76	1.71	1.77	1.80	1.83	1.80	1.80	1.77	1.80	1.79	4'-7"-2021
4'-7"-2023	1.73	1.73	1.68	1.73	1.73	1.77	1.75	1.76	1.68	1.68	1.65	1.68	1.66	1.67	1.77	1.78	1.76	1.75	1.72	1.73	1.75	4'-7"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.06	0.05	0.06	0.07	0.06	0.04	0.05	0.04	0.06	0.09	0.10	0.07	0.06	0.11	0.04	0.05	0.03	0.06	0.05	0.07	0.04	2021-2023
5'-3"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5'-3"-
5'-3"-2021	1.80	1.77	1.78	1.82	1.79	1.82	1.82	1.82	1.75	1.80	1.77	1.77	1.73	1.79	1.83	1.83	1.81	1.87	1.81	1.82	1.81	5'-3"-2021
5'-3"-2023	1.75	1.74	1.72	1.76	1.74	1.79	1.79	1.78	1.68	1.73	1.69	1.71	1.66	1.72	1.79	1.80	1.76	1.78	1.78	1.76	1.77	5'-3"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.05	0.03	0.06	0.06	0.04	0.03	0.02	0.04	0.07	0.07	0.08	0.06	0.07	0.07	0.05	0.03	0.05	0.09	0.03	0.06	0.04	2021-2023
5'-11"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5'-11"-
5'-11"-2021	1.83	1.80	1.81	1.82	1.80	1.82	1.85	1.81	1.76	1.82	1.81	1.80	1.73	1.80	1.85	1.85	1.83	1.82	1.83	1.84	1.82	5'-11"-2021
5'-11"-2023	1.77	1.73	1.76	1.78	1.77	1.79	1.80	1.79	1.70	1.75	1.72	1.74	1.68	1.75	1.80	1.81	1.77	1.80	1.81	1.79	1.77	5'-11"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.06	0.07	0.04	0.04	0.03	0.02	0.05	0.02	0.06	0.08	0.09	0.06	0.05	0.05	0.05	0.04	0.06	0.03	0.01	0.05	0.05	2021-2023
6'-7"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6'-7"-
6'-7"-2021	1.85	1.84	1.84	1.85	1.82	1.85	1.85	1.85	1.75	1.83	1.83	1.82	1.74	1.81	1.84	1.87	1.85	1.85	1.87	1.85	1.83	6'-7"-2021
6'-7"-2023	1.79	1.81	1.79	1.80	1.78	1.81	1.83	1.82	1.70	1.77	1.74	1.77	1.68	1.79	1.82	1.84	1.80	1.82	1.81	1.82	1.81	6'-7"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.05	0.03	0.05	0.05	0.05	0.04	0.02	0.02	0.06	0.06	0.09	0.05	0.06	0.02	0.02	0.03	0.05	0.02	0.06	0.03	0.02	2021-2023
7'-3"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7'-3"-
7'-3"-2021	1.86	1.85	1.87	1.86	1.82	1.88	1.87	1.85	1.79	1.83	1.83	1.83	1.79	1.85	1.86	1.88	1.83	1.88	1.88	1.86	1.86	7'-3"-2021
7'-3"-2023	1.83	1.82	1.85	1.83	1.81	1.83	1.85	1.82	1.72	1.78	1.78	1.79	1.71	1.79	1.85	1.85	1.80	1.83	1.83	1.85	1.84	7'-3"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.03	0.03	0.02	0.03	0.01	0.05	0.02	0.03	0.06	0.04	0.04	0.04	0.08	0.06	0.01	0.03	0.01	0.05	0.05	0.02	0.02	2021-2023
7'-10"-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7'-10"-
7'-10"-2021	1.87	1.86	1.87	1.87	1.86	1.89	1.89	1.87	1.85	1.87	1.87	1.86	1.81	1.86	1.90	1.88	1.87	1.88	1.89	1.89	1.89	7'-10"-2021
7'-10"-2023	1.85	1.85	1.86	1.85	1.83	1.86	1.88	1.83	1.77	1.82	1.82	1.81	1.75	1.83	1.85	1.86	1.79	1.85	1.86	1.86	1.86	7'-10"-2023
2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2021
2021-2023	0.02	0.02	0.02	0.02	0.03	0.03	0.01	0.03	0.07	0.05	0.06	0.06	0.06	0.03	0.04	0.02	0.08	0.03	0.03	0.04	0.03	2021-2023

NOTE: THE TABLE OF VALUES IS PRESENTED AS **SIDE FRONT WAS OBSERVED FROM ITS OUTSIDE.**

THICKNESS VALUES ARE EXPRESSED IN INCHES, FIGURES FOR KETTLE DEPTHS AND LENGTHS ARE EXPRESSED IN FEET-INCHES.

THE RED VALUES ARE MEASUREMENTS IN CLOSE PROXIMITY TO THE BURNERS. THE LIGHT-BLUE CELLS ARE THE LOWEST 20 VALUES MEASURED ON THE KETTLE LONG SIDE.

K.I.D. TECHNOLOGY HAS A MARGIN OF ERROR ±0.059''

Zinc Protects Steel®

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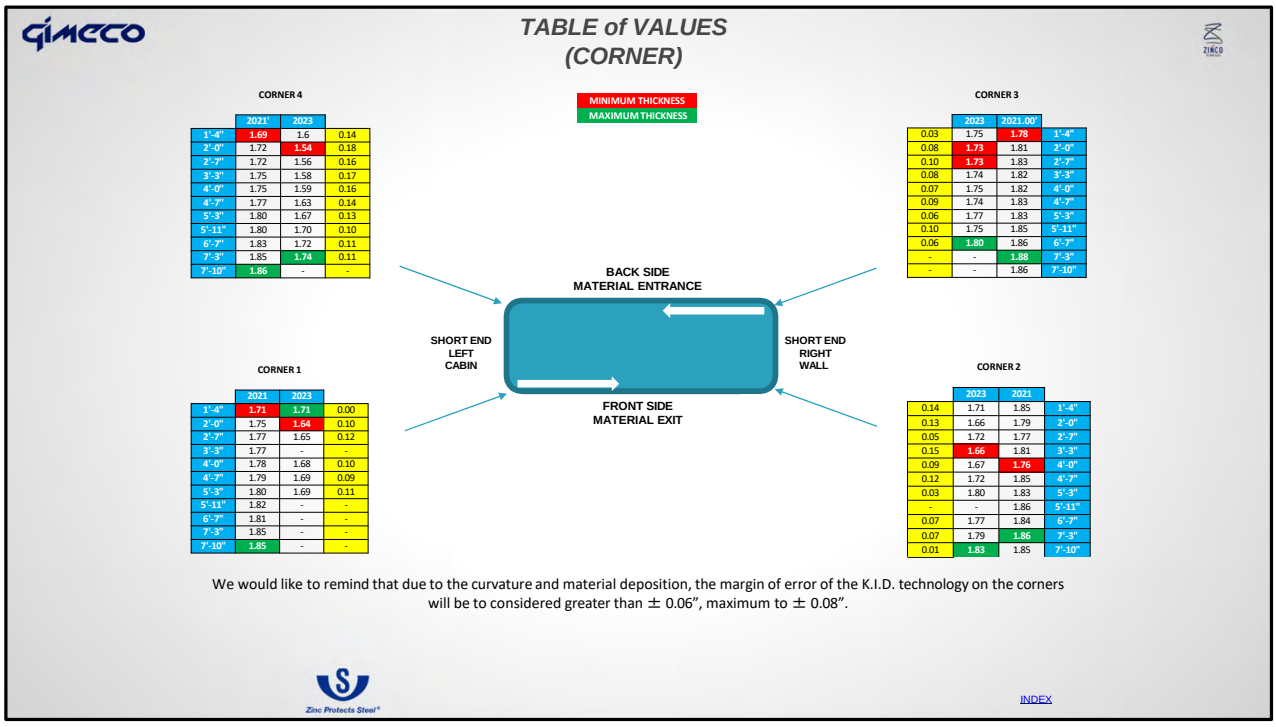
Comparison to prior tests showing loss over a period of time at each grid point.



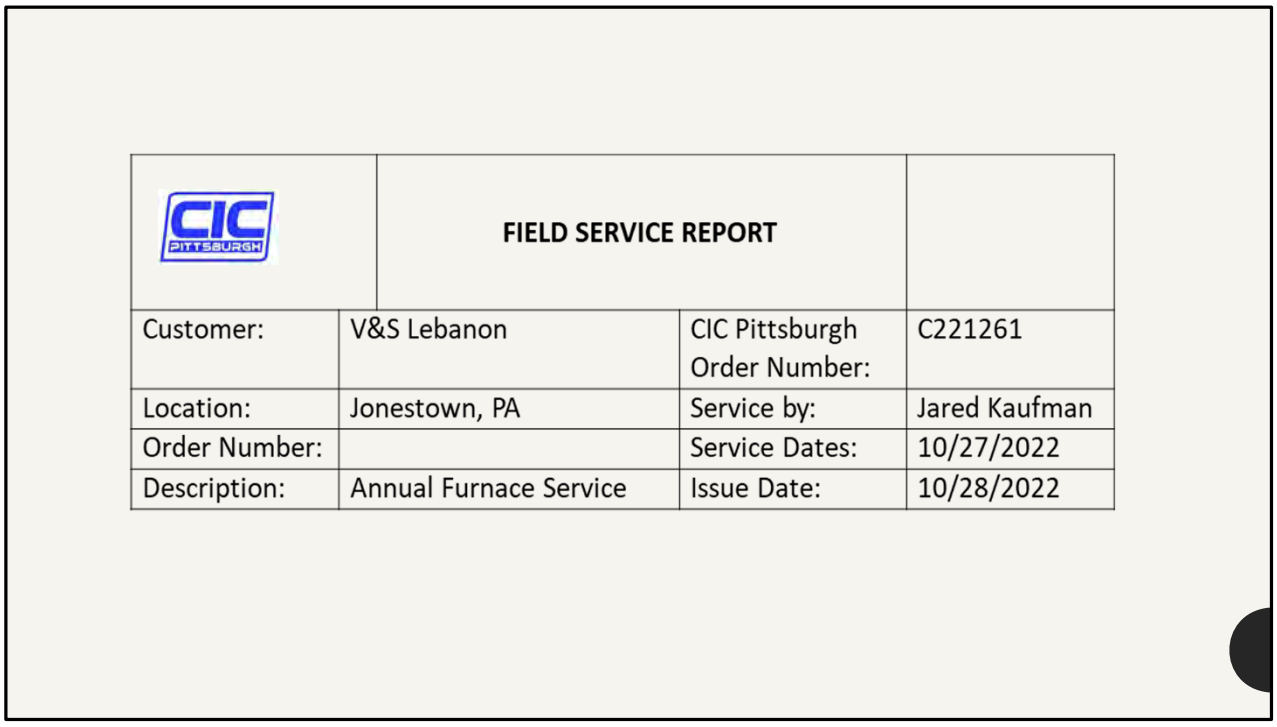
CORNER 4			
	2021'	2023	
1'-4"	1.69	1.6	0.14
2'-0"	1.72	1.54	0.18
2'-7"	1.72	1.56	0.16
3'-3"	1.75	1.58	0.17
4'-0"	1.75	1.59	0.16
4'-7"	1.77	1.63	0.14
5'-3"	1.80	1.67	0.13
5'-11"	1.80	1.70	0.10
6'-7"	1.83	1.72	0.11
7'-3"	1.85	1.74	0.11
7'-10"	1.86	-	-

CORNER 3			
	2023	2021.00'	
0.03	1.75	1.72	1'-4"
0.08	1.73	1.81	2'-0"
0.10	1.73	1.83	2'-7"
0.08	1.74	1.82	3'-3"
0.07	1.75	1.82	4'-0"
0.09	1.74	1.83	4'-7"
0.06	1.77	1.83	5'-3"
0.10	1.75	1.85	5'-11"
0.06	1.80	1.86	6'-7"
-	-	1.88	7'-3"
-	-	1.86	7'-10"

CORNER 1			
	2021	2023	
1'-4"	1.71	1.71	0.00
2'-0"	1.75	1.64	0.10
2'-7"	1.77	1.65	0.12
3'-3"	1.77	-	-
4'-0"	1.78	1.68	0.10
4'-7"	1.79	1.69	0.09
5'-3"	1.80	1.69	0.11
5'-11"	1.82	-	-
6'-7"	1.81	-	-
7'-3"	1.85	-	-
7'-10"	1.85	-	-

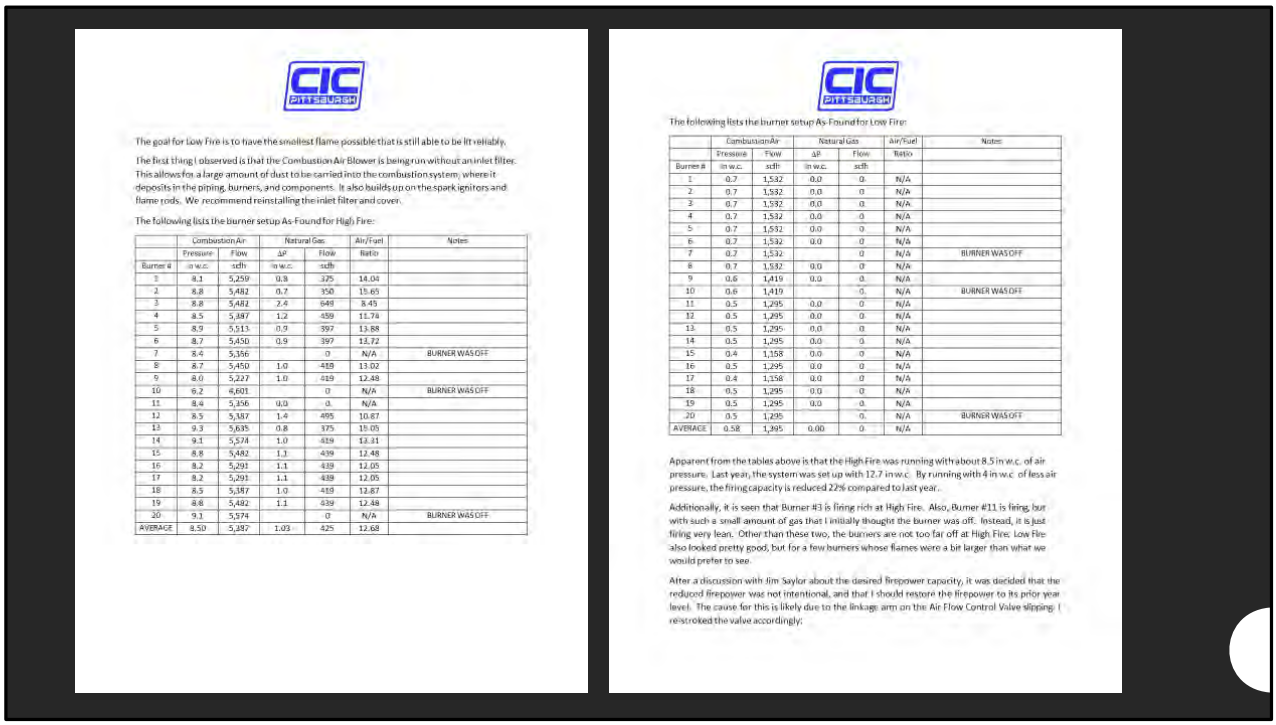
CORNER 2			
	2023	2021	
0.14	1.71	1.85	1'-4"
0.13	1.66	1.79	2'-0"
0.05	1.72	1.77	2'-7"
0.15	1.66	1.81	3'-3"
0.09	1.67	1.76	4'-0"
0.12	1.72	1.85	4'-7"
0.03	1.80	1.83	5'-3"
-	-	1.86	5'-11"
0.07	1.77	1.84	6'-7"
0.07	1.79	1.86	7'-3"
0.01	1.83	1.85	7'-10"

Corner and end wall readings.



	FIELD SERVICE REPORT		
Customer:	V&S Lebanon	CIC Pittsburgh Order Number:	C221261
Location:	Jonestown, PA	Service by:	Jared Kaufman
Order Number:		Service Dates:	10/27/2022
Description:	Annual Furnace Service	Issue Date:	10/28/2022

Another great change we made is annual furnace inspections and tune ups on all our kettles.



The goal for Low Fire is to have the smallest flame possible that is still able to be lit reliably.

The first thing I observed is that the Combustion Air Blower is being run without an inlet filter. This allows for a large amount of dust to be carried into the combustion system, where it deposits in the piping, burners, and components. It also builds up on the spark ignitors and flame rods. We recommend reinstalling the inlet filter and cover.

The following lists the burner setup As-Found for High Fire:

	Combustion Air		Natural Gas		Air/Fuel	Notes
	Pressure	Flow	ΔP	Flow	Ratio	
Burner #	in w.c.	scfh	in w.c.	scfh		
1	8.1	5,259	0.8	325	14.04	
2	8.8	5,482	0.7	350	13.65	
3	8.8	5,482	2.4	648	8.45	
4	8.5	5,387	1.2	459	11.74	
5	8.9	5,513	0.9	397	13.88	
6	8.7	5,450	0.9	397	13.72	
7	8.4	5,356		0	N/A	BURNER WAS OFF
8	8.7	5,450	1.0	419	13.02	
9	8.0	5,227	1.0	419	12.48	
10	6.2	4,601		0	N/A	BURNER WAS OFF
11	8.4	5,356	0.0	0	N/A	
12	8.5	5,387	1.4	495	10.87	
13	9.3	5,635	0.8	375	15.05	
14	9.1	5,574	1.0	439	12.71	
15	8.8	5,482	1.1	439	12.48	
16	8.2	5,291	1.1	439	12.05	
17	8.2	5,291	1.1	439	12.05	
18	8.5	5,387	1.0	419	12.87	
19	8.8	5,482	1.1	439	12.48	
20	9.1	5,574		0	N/A	BURNER WAS OFF
AVERAGE	8.50	5,387	1.03	425	12.68	

The following lists the burner setup As-Found for Low Fire:

	Combustion Air		Natural Gas		Air/Fuel	Notes
	Pressure	Flow	ΔP	Flow	Ratio	
Burner #	in w.c.	scfh	in w.c.	scfh		
1	0.7	1,532	0.0	0	N/A	
2	0.7	1,532	0.0	0	N/A	
3	0.7	1,532	0.0	0	N/A	
4	0.7	1,532	0.0	0	N/A	
5	0.7	1,532	0.0	0	N/A	
6	0.7	1,532	0.0	0	N/A	
7	0.7	1,532		0	N/A	BURNER WAS OFF
8	0.7	1,532	0.0	0	N/A	
9	0.6	1,419	0.0	0	N/A	
10	0.6	1,419		0	N/A	BURNER WAS OFF
11	0.5	1,295	0.0	0	N/A	
12	0.5	1,295	0.0	0	N/A	
13	0.5	1,295	0.0	0	N/A	
14	0.5	1,295	0.0	0	N/A	
15	0.4	1,158	0.0	0	N/A	
16	0.5	1,295	0.0	0	N/A	
17	0.4	1,158	0.0	0	N/A	
18	0.5	1,295	0.0	0	N/A	
19	0.5	1,295	0.0	0	N/A	
20	0.5	1,295		0	N/A	BURNER WAS OFF
AVERAGE	0.58	1,395	0.00	0	N/A	

Apparent from the tables above is that the High Fire was running with about 8.5 in w.c. of air pressure. Last year, the system was set up with 12.7 in w.c. By running with 4 in w.c. of less air pressure, the firing capacity is reduced 22% compared to last year.

Additionally, it is seen that Burner #3 is firing rich at High Fire. Also, Burner #11 is firing, but with such a small amount of gas that I initially thought the burner was off. Instead, it is just firing very lean. Other than these two, the burners are not too far off at High Fire. Low Fire also looked pretty good, but for a few burners whose flames were a bit larger than what we would prefer to see.

After a discussion with Jim Saylor about the desired firepower capacity, it was decided that the reduced firepower was not intentional, and that I should restore the firepower to its prior year level. The cause for this is likely due to the linkage arm on the Air Flow Control Valve slipping. I re-stroked the valve accordingly.

As found settings combustion air, natural gas and fuel ratio high fire and low fire.

	As-Found	As-Adjusted
High Fire Air Pressure:	8.8 in w.c.	13.9 in w.c.
Low Fire Air Pressure:	0.2 in w.c.	0.4 in w.c.

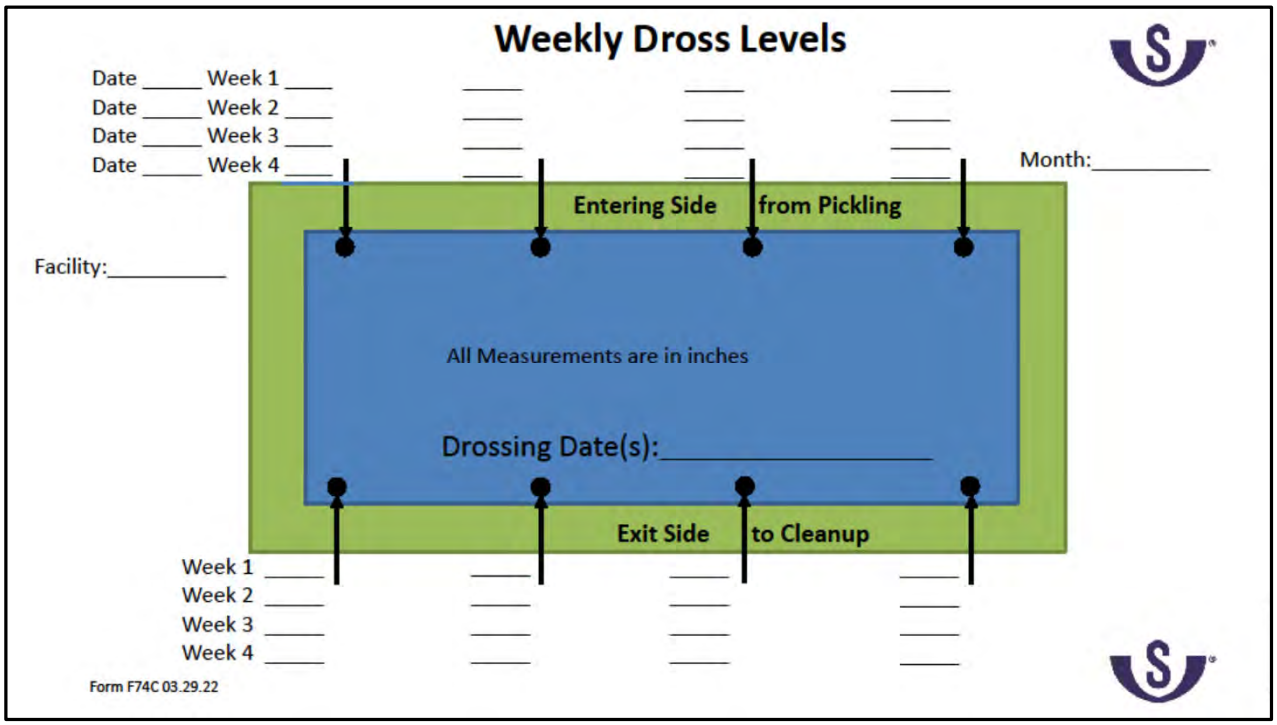
With the air valve stroked, I tuned the burners, targeting the following settings:

	Combustion Air		Natural Gas		Air/Fuel	Notes
	Pressure	Flow	ΔP	Flow	Ratio	
	in w.c.	scfh	in w.c.	scfh		
HIGH FIRE	12.5	6,533	1.7	546	11.97	

The following lists the burner setup As-Adjusted for High Fire:

	Combustion Air		Natural Gas		Air/Fuel	Notes
	Pressure	Flow	ΔP	Flow	Ratio	
Burner #	in w.c.	scfh	in w.c.	scfh		
1	12.3	6,481	1.7	546	11.87	
2	13.6	6,815	1.6	538	12.67	
3	12.9	6,637	1.7	546	12.16	
4	13.0	6,663	1.7	546	12.20	
5	12.6	6,559	1.7	546	12.01	
6	13.3	6,688	1.7	546	12.25	
7	12.7	6,585	1.7	546	12.06	
8	13.0	6,663	1.7	546	12.20	
9	12.4	6,507	1.7	546	11.92	
10	12.8	6,611		0.	N/A	BURNER WAS OFF
11	12.6	6,559	1.7	546	12.01	
12	13.2	6,454	1.7	546	11.82	
13	12.2	6,428	1.7	546	11.77	
14	11.5	6,266	1.7	546	11.48	
15	12.2	6,428	1.7	546	11.77	
16	11.8	6,348	1.7	546	11.63	
17	12.6	6,559	1.7	546	12.01	
18	13.0	6,663	1.7	546	12.20	
19	12.5	6,533	1.7	546	11.97	
20	12.3	6,481	1.7	546	11.87	
AVERAGE	12.56	6,547	1.69	545	12.01	

Then he will do full burner troubleshooting of all burners problems and ones not lighting.
Then all combustion air, natural gas and air fuel ratio settings are adjusted for optimal performance.
This is also a great training period for maintenance or workers that are assisting with this service.
They will then report on other issues they see and make final comments.



Very important in making sure this is being done correctly.
Probe should have a depth indicator, so you know you are on the bottom of the kettle.
We have probes with a short 1” 90 deg. Bend so you can feel dross easier and can also use to check lead layer

DAILY KETTLE CHECKLIST

V&S Facility: _____ Shift: _____ Month: _____

Week		Zinc Management		Cleaning Processes			Initials
		Inches from top to Zinc	Pounds Added Zinc	Scraped Kettle Wall	Swept Floor	Lime Kettle	
1	Monday						
	Tuesday						
	Wednesday						
	Thursday						
	Friday						
	Saturday						
	Sunday						
2	Monday						
	Tuesday						
	Wednesday						
	Thursday						
	Friday						
	Saturday						
	Sunday						
3	Monday						
	Tuesday						
	Wednesday						
	Thursday						
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	Saturday						
	Sunday						
4	Monday						
	Tuesday						
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	Saturday						
	Sunday						
5	Monday						
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	Wednesday						
	Thursday						
	Friday						
	Saturday						
	Sunday						

Form F46a 04.11.22

Drossing Procedure

Standard Operating Procedures SOP-14

06.03.21
Edition 2
Page: 1 of 5

Drossing is the process of removing iron-rich zinc from the bottom of the galvanizing kettle, called Bottom Dross. Bottom Dross build-up can cause quality problems on galvanizing surfaces, reduces the amount of space available in the kettle, and dross leads to more dross (as iron particles are constantly growing zinc coatings). At V&S, we have developed a specific process to determine the depth of the Bottom Dross and to remove the Bottom Dross. Essentially the Dross Shovel is lowered into the molten zinc (with a bridge crane) and is pushed through the kettle using two forklifts. The forklifts apply force to the pusher beam connected to the shovel. The shovel is then raised with the bridge crane and material in the shovel is worked and removed.

Understanding the Lead Level

The Lead level below the Bottom Dross shall be between ¼ to 3 inches. Low Lead levels will make it harder to dross and High Lead levels will raise the dross level above the insulation and closer to burner area. The lead at the bottom also assists the Dross Shovel run under dross when you get to the bottom of kettle. Drossing helps mix lead back up into the Zinc as the shovel starts pushing through the Lead layer. The bottom dross will get hard and seal lead off from the zinc which is why when Lead level alloyed in the Zinc drops. When this occurs, the only way to raise the Lead level in the bath is to add more raw materials. The preferred method to increase the Lead is via proper Drossing; alternatively, nitrogen purge after full drossing will also increase the Lead levels within the Zinc.

Testing Dross Depth

Materials and Procedure to test the Bottom Dross thickness:

Hooked bar with full kettle depth markings on the apparatus

Extend the bar into the molten zinc. If it full-depth marking stops above the kettle, this distance should be noted as the thickness of the Bottom Dross. Continue working/forcing hooked bar into the dross until breakthrough is noted. Rotate hooked bar to then determine and note the lead level that is beneath the dross.

DROSS REMOVAL

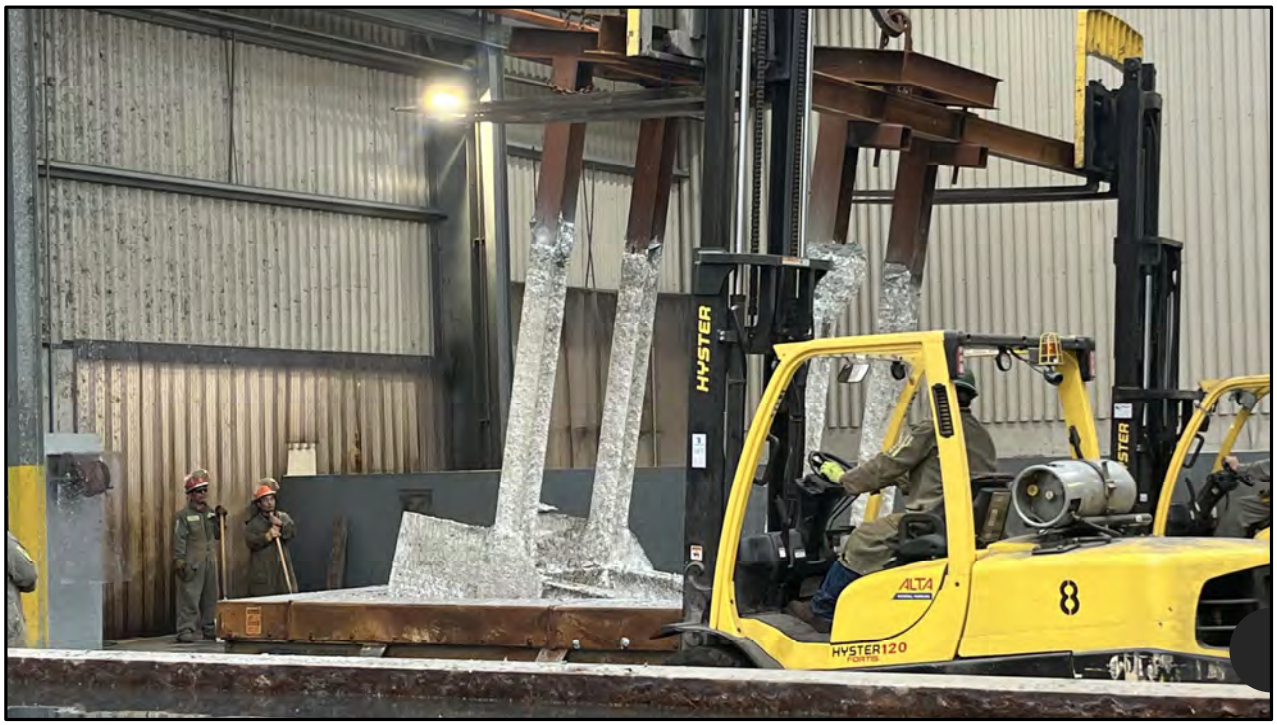
Frequency: Dross Removal must be completed at intervals of 2-4 weeks (at least once per month) with no exceptions. Failure to do so will result in an ISO Corrective Action and a Financial Penalty/Fine levied by Voigt & Schweitzer.

Controlled ISO document daily kettle cleaning which includes zinc added inches from the top.
Then it goes over cleaning walls sweeping floors and liming top plate if necessary
Next document is Drossing SOP, 5 page in depth process procedure.

Picture showing 3/4” boiler plate shovel and large number of holes. Shovel should be more than ½ the width of the kettle, so each pass is always cleaning a wall. Rotating back and forth cleaning entire floor.

Another shovel picture of cleaning holes.
Make sure your holes are round and all the same size so you can clean dirt buildup occasionally.
Hammer drill with properly sized bit work great to just blow ash build up out of hole so you keep proper drainage.

New shovel for long kettle so we added scoop at each end. Turning shovels to go the opposite direction is very dangerous and time consuming..
Ols shovels were very hard to keep clean with I-beam construction resulting in them floating because of buildup in areas.
New shovels are being made from old kettle steel plate making it much easier to keep clean.



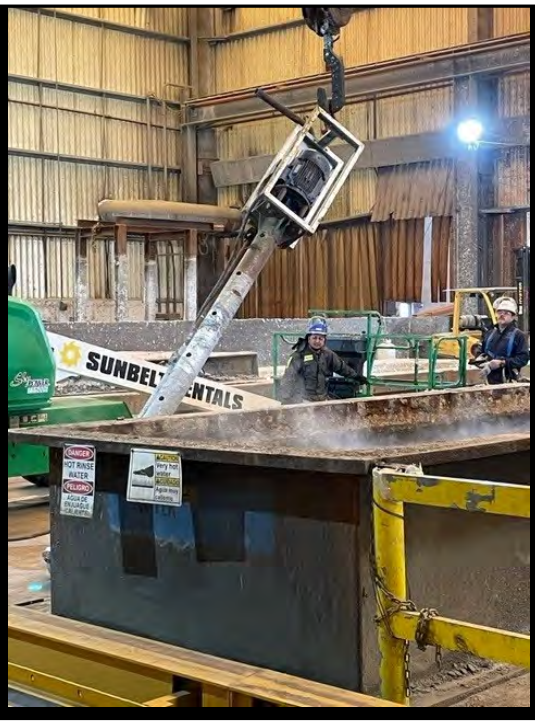
Shorter shovels tend to want to lean forward when lifting out of the kettle because the weight of dross in the bucket.
We pin our push beam on for a bit of counterweight to the back of fixture.

This shovel is long enough where it will stay level while pushing.

You will see in this video the shorter shovels will want to tilt forward as we are pushing them.
We put the forks over the beam to push shovel, so it doesn't allow back of the shovel to lift as scoop is filling.

We work dross over kettle to get majority of zinc back into the kettle then again on the floor after we throw some flux zinc from Zaclon in to get as much zinc reclaimed as possible.

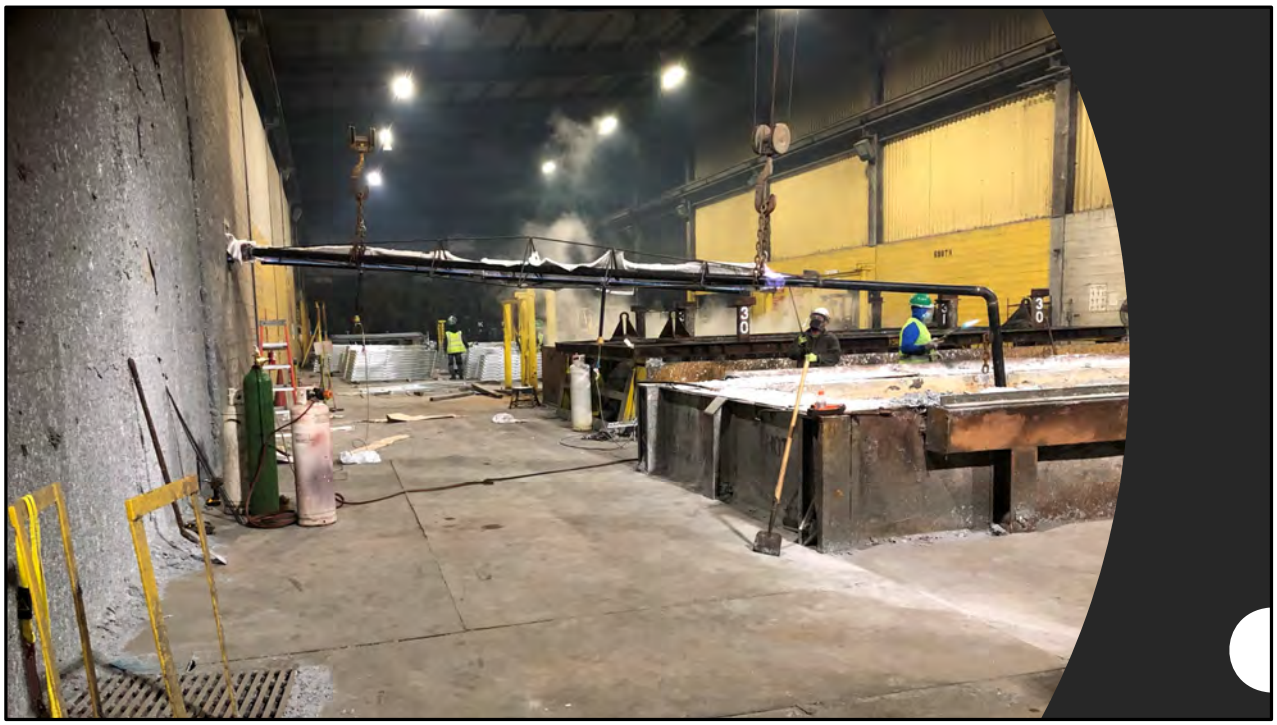
Picture of the nice grainy dross with zinc worked out.
Barry Dugan says good dross only has 2 ½% to 3% iron in it.



Outside zinc pumping company getting zinc pump set up to fill holding vessels.
After they will pump to our pans using our employees.

Pre-heating pump is the most stressful time. If you turn on before it is ready, and you freeze up your pipe you just lost 1-2 hours.
We use a couple of infrared thermometers to make sure pipe is hot enough.
You have to make sure all flange joints, up pipe at the pump, zinc level at pump and elbows are good and hot.
Once the zinc starts flowing you are good but I hold my breath every time.

Bought some straight pipe burner components with several venturis, regulators and control valves to make pipe preheaters.
Pumping smaller spinner kettle to larger kettle and back for kettle change distance was 50-60 feet.
Worried about being able to make sure pipe will be hot enough so zinc doesn't freeze.
You can see in the back our electrician is always in eyesight when pumping, controlling speed, amp draw and emergency stopping.



Guys pre-heating pipe to start pumping.

Filling pans at 29’ kettle 690,000#’s of zinc.
3 holding vessels 150,000#’s each =450,000-690,000= 240,000#’s remain.
Our pans hold 6,500#’s when they must be moved since they can’t be filled to the top.
We are pumping approx.. 37 pans.

Had some pump problems and since time starts ticking when you start pumping, we decided to scoop the remaining zinc.
We had about 120 pans to fill with two scoops going to either side of the kettle.
Two bridge cranes working with one scoop filling and one scoop dumping.
Took 5 hours to empty kettle this way.
Once you start getting below burners you have very little heat going into zinc, so it starts to cool quickly.
We transfer zinc at 865 deg. F to help give a little more of a cushion.

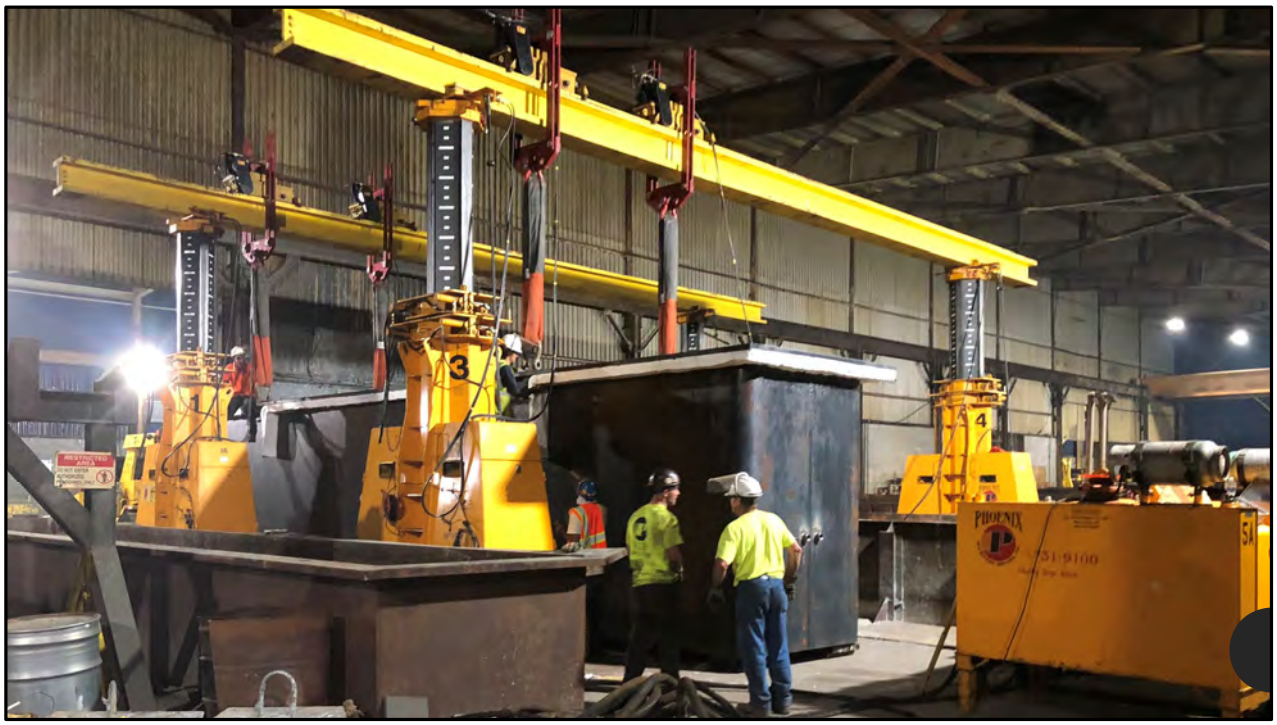
Empty kettle we need to start cooling by ripping top plates off and spraying some water on it.
Need to cool in 8 hours to be able to safely rig and remove from furnace.

Zinc removed from pans and ready to stack in new kettle.

Clean, inspect and repair any areas of concern to get ready for new kettle.

Make sure you have the right equipment.

500-ton 4-point power tower gantry.
When lifted entire gantry will roll on tracks over this pit to get to cleaning floor.
Track not set up at the kettle because we need to pump yet.
Set new kettle in holding pit so we can start stacking bottom and we can leave old kettle on floor to cut up.



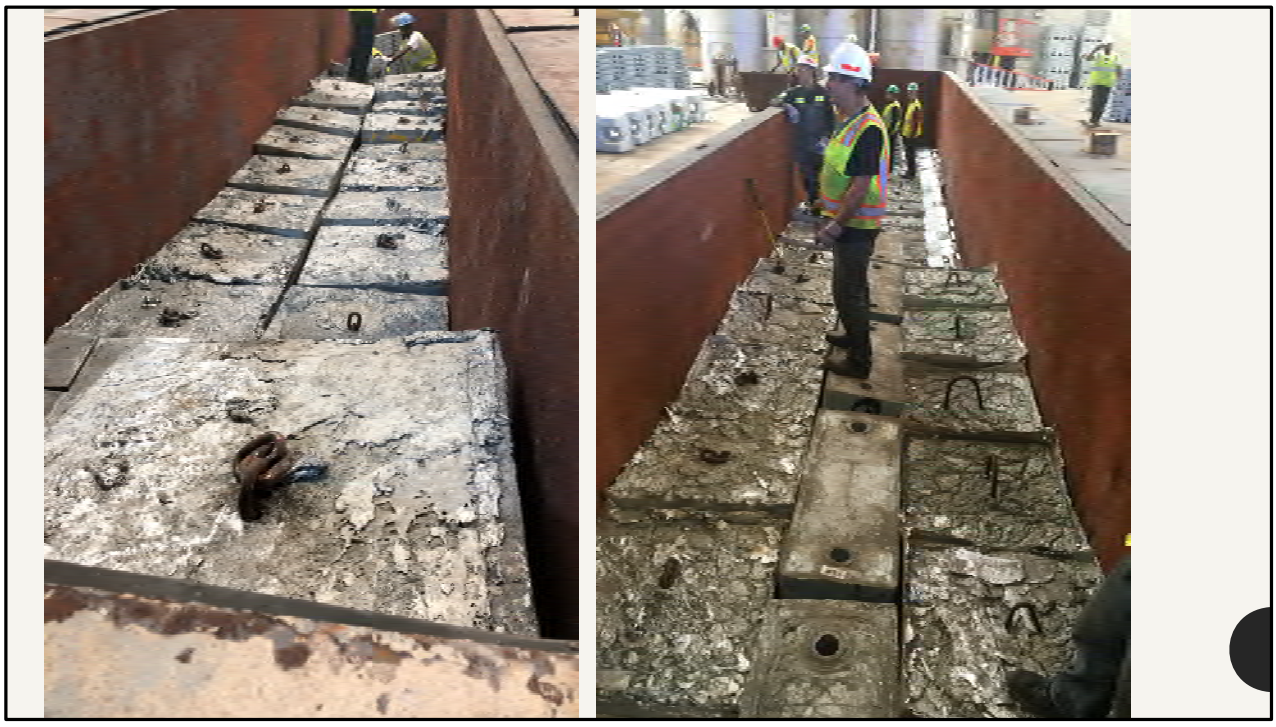
Different kettle and 500-ton power tower set.
This kettle the gantry won't move the trolleys on the beams will roll hydraulicly.

New kettle being rigged at the same time wool is going on.

New kettle with wool installed getting ready to go into the hole.

Another kettle going in.
Make sure you get enough track, so you don't need to move after shimming and leveling.
We tried to do it and move pieces, but it was too costly in time that was lost.
Track is nice because it spreads the load out.
Make sure your furnace pits can support the loads.

Stacking the bottoms is always very time consuming.
The pattern must be figured out then its slab by slab to have entire bottom and 14-16 inches up the wall covered.



Kettle on the left is much easier to stack with the used chain verse blocks with lifting irons.

V&S team stacking zinc.
Managers and maintenance from most plants assist in all changes.

Cleaning up old kettle during meltdown period.

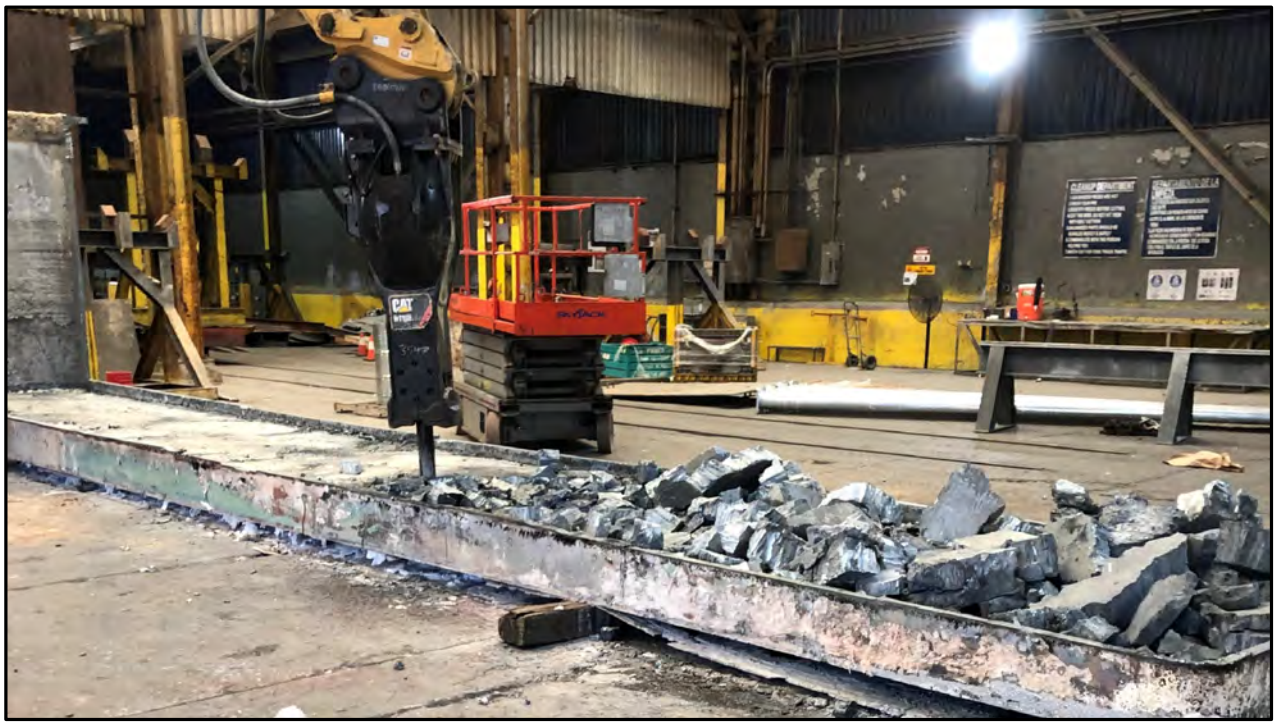
Removing manageable pieces of old kettle

Having the right equipment so you are not damaging cranes by overloading and lifting with forklifts not knowing weight of what is being lifted.
This track hoe gives the ability to safely break pieces off after being cut.

Easiest way we found to break up heel left in kettle was by large track hoe with large breaker hammer and sharpened wedge chisel point point.

This kettle had 2’ to 3’ material left in and had to be cleaned quickly to lighten it up to lift.
This kettle residue was broken up and scooped out with a bucket on right to make us comfortable to lift it.

Kettle cleaned out overnight while it was cooling.
Now it will be rigged and pulled out of the furnace.



Another kettle bottom being cleaned.
All kettles we put material back into new kettle after full meltdown over the next few weeks.
We all have lead layers in the bottom and the remaining dross will be cleaned out of the new kettle.

Kettle bottom almost cleaned ready to cut.

Old kettle cleaned up ready to go to scrap yard before new kettle is melted down.

Pumping back 25’ kettle.
With 3 holding vessels only a small amount of solid zinc was needed.
After pumping this kettle was ready to galvanize 8 hours later.

Another pump back from vessels with molten zinc.

First kettle change at the Lebanon plant.