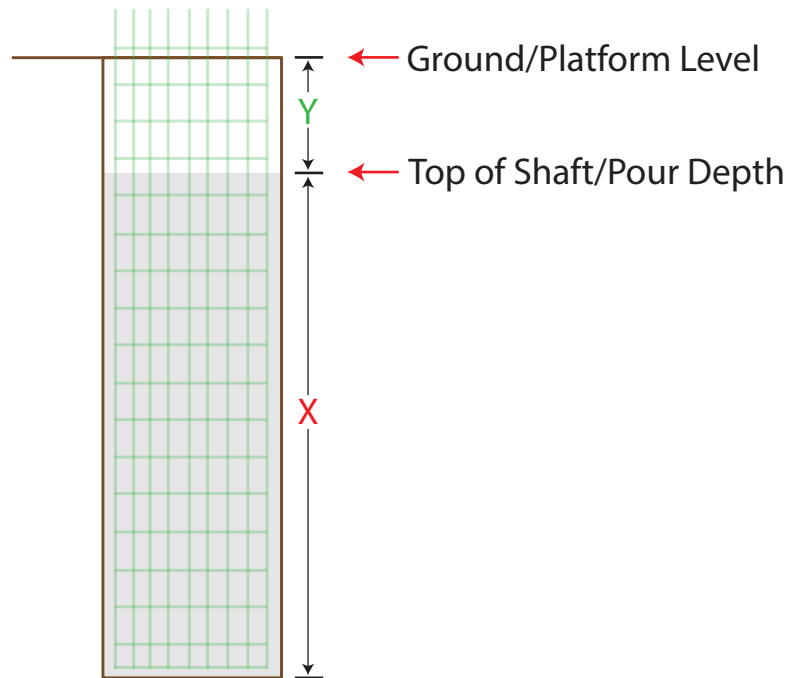


Thermal Wire® Project Calculation and Installation Guide



-
- Thermal Wire® is sold in 5' increments and comes from the factory pre-programmed to work with TAP data loggers.
 - Standard stock sizes range from 35' to 105', other lengths are made to order.
 - Each wire has non-instrumented lead cable at the top to allow for flexibility in data logger placement at the top of shaft. Standard lead lengths are 15', 25', 50', 75', and 100'. All stock wires have 15' leads.
 - For piles requiring cages that are spliced while hanging, wires are manufactured in sections with quick connect plugs.
 - Proper planning is necessary to ensure enough cable to capture data, but also reduce potential waste.

Thermal Wire® Planning - Non-Spliced Cages



X = Distance from top of shaft to toe

Y = Distance from top of shaft to platform level

Instrumented length

(Instrumented length is calculated from the top of concrete to the shaft toe)

= X rounded up to the next highest 5' increment

(if depth is within 2.5' of next increment, move up one more 5' increment to allow for flexibility)

Ex. a) $X = 31.5'$

Instrumented wire length should be 35'

Ex. b) $X = 33.5'$

Instrumented wire length should be 40'

Lead Length

(Lead is calculated from top of shaft to best access point above ground level. This could be ground level, top of casing, platform level etc....)

= Y rounded up to the closest stock lead length

(Stock lead lengths 15', 25', 50', 75', 100')

Ex. a) $Y = 3.5'$

Lead wire length should be 15'

Ex. b) $Y = 42.5'$

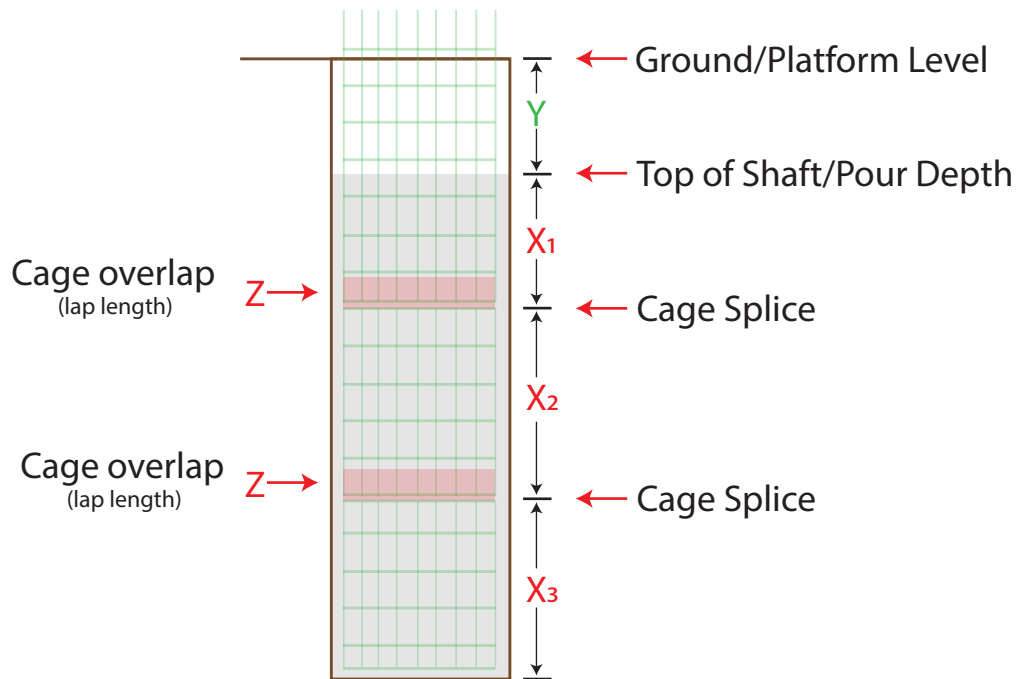
Lead wire length should be 50'

Per ASTM D7949, Thermal Integrity Profiling requires one full length Thermal Wire® per foot of shaft diameter. On drilled shafts, typically a minimum four wires is recommended for easier interpretation of cage shifting.

Thermal Wire® Planning - Spliced Cages

(cages spliced while hanging)

Follow this procedure for multi-section cages of any number two or higher



X_1 = Top of pour to bottom of top cage section

X_2 = Middle section cage length

X_3 = Bottom section cage length

Z = Cage overlap (lap length)

Y = Distance from top of shaft to platform level

Instrumented length

-When calculating section lengths for shafts with spliced cages you **always work from the bottom up**. The last sensor in the multi-section chain is the end of the bottom cage section.

Bottom Section

(start length calculations here)

= X_3 minus Z , rounded up to the next highest 5' increment

(if depth is within 2.5' of next increment, move up one more 5' increment to allow for flexibility at splice)

Ex. a) $X_3 = 35.4'$ and $Z = 3.5'$;

$$X_3 - Z = 31.9'$$

Wire section length should be 35'

Ex. b) $X_3 = 38.4'$ and $Z = 3.5'$;

$$X_3 - Z = 34.9'$$

Wire section length should be 40'

Middle Section

(move to middle section(s) after bottom section length is determined)

= X_2 minus Z , rounded up to the next highest 5' increment

(if depth is within 2.5' of next increment, move up one more 5' increment to allow for flexibility at splice)

Ex. a) $X_2 = 35.4'$ and $Z = 3.5'$;

$$X_2 - Z = 31.9'$$

Wire section length should be 35'

Ex. b) $X_2 = 38.4'$ and $Z = 3.5'$;

$$X_2 - Z = 34.9'$$

Wire section length should be 40'

Top Section

(move to this section after middle section(s) length is determined, or bottom section length is determined in a two section cage)

= X_1 rounded up to the next highest 5' increment

(if depth is within 2.5' of next increment, move up one more 5' increment to allow for flexibility)

Ex. a) $X_1 = 35.4'$

Wire section length should be 40'

Ex. b) $X_1 = 38.4'$

Wire section length should be 40'

Lead Length

(Lead is calculated from top of shaft to best access point above ground level. This could be ground level, top of casing, platform level etc....)

= Y rounded up to the closest stock lead length

(Stock lead lengths 15', 25', 50', 75', 100')

Ex. a) $Y = 3.5'$

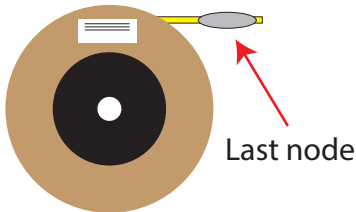
Lead wire length should be 15'

Ex. b) $Y = 42.5'$

Lead wire length should be 50'

Thermal Wire® Installation

Thermal Wires® are delivered on spools with the last/bottom node being the first one to come off. The spool label contains information about the wire/wire section. Unspool the wire from the top of the cage to the bottom.



Standard Cable

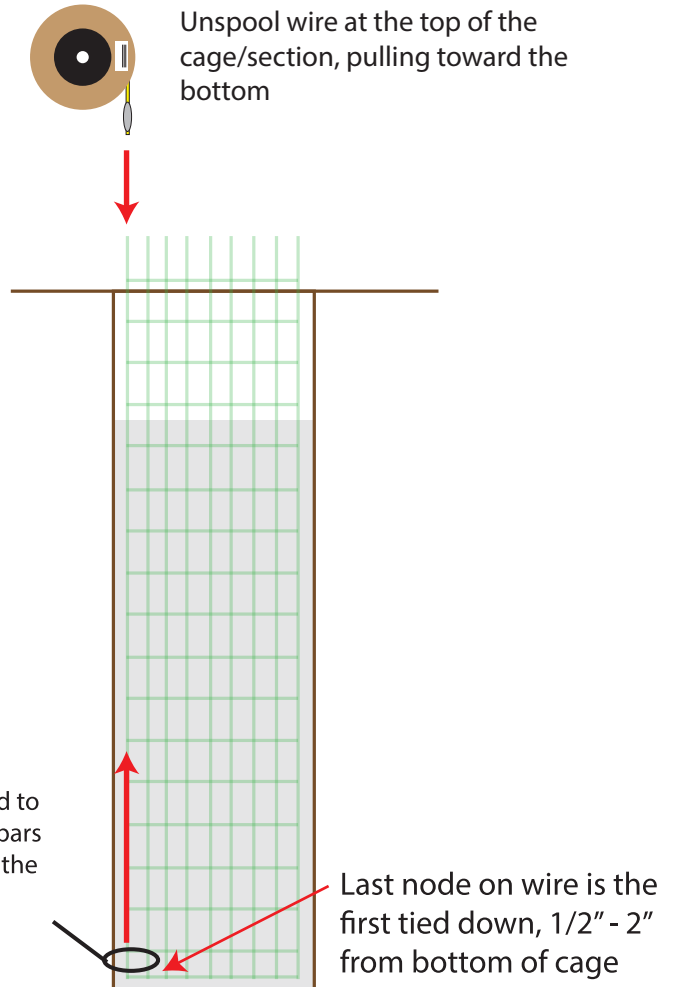
	Thermal Wire® Cable	12345 PF
		S/N
	105' - 15'	
	Cable Length	Lead Length

Sectioned Cable

	Thermal Wire® Cable	12345 PF
		S/N
Top60' - 25L	1 of 3	165
Section Description	Section	Cable Total Nodes

RECOMMENDATIONS

- **DO NOT pretension ThermalWires before tightening cable ties**
- DO make sure zip ties are tight, without tensioning the ThermalWire
- Run straight on longitudinal bars
- Do not install facing the inside or outside of the cage
- Avoid cage lift points
- Avoid reinforcements that will be removed later
- Avoid centralizers
- Avoid tie wires that could damage ThermalWire
- Avoid jumping from one bar to another
- Avoid crossing over from one side of a bar to another
- Do not install on or adjacent to CSL tubes
- Avoid walking on, torching or cutting near, and grabbing wires while preparing the cage
- Keep wire coiled up just below top lift point while cage is lifted and lowered into hole



Thermal Wire® Installation

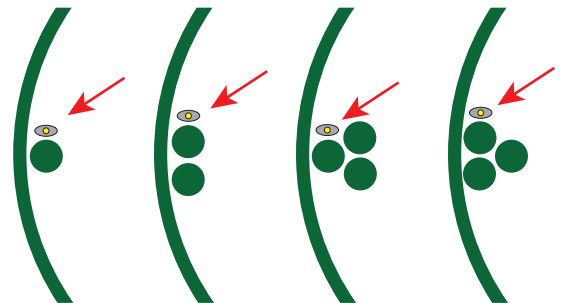
Proper Wire Placement:



90° offset from inside or outside of the cage.

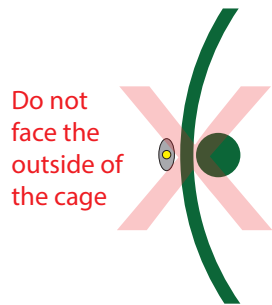
Protects against damage caused by cage bumping side walls during lowering and tremie movements during pour

Various cage designs

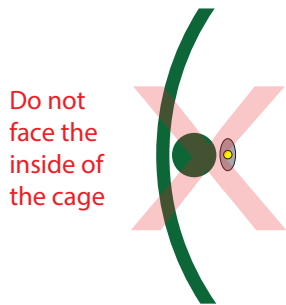


Improper Wire Placement:

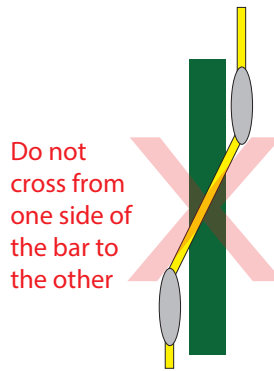
Things to avoid



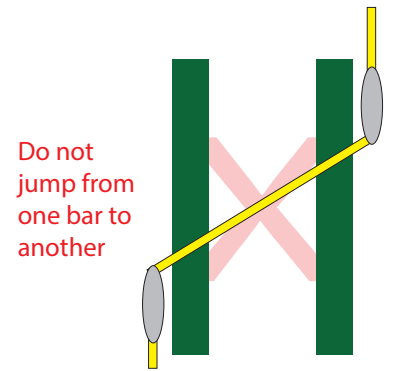
Do not face the outside of the cage



Do not face the inside of the cage



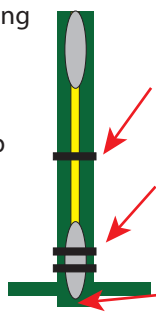
Do not cross from one side of the bar to the other



Do not jump from one bar to another

Proper Installation Method:

When cable tying ThermalWire, work from the bottom of the cage to the top



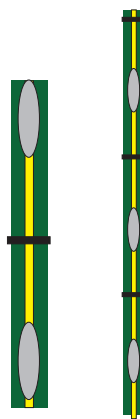
1 cable tie halfway between last and second to last nodes

2 cable ties on last node

1/2" (1.27cm) from bottom

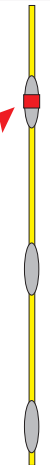
Bottom of Cage

Once the bottom node is locked in, put 1 cable tie approximately halfway between every node



IMPORTANT NOTE:

Any node wrapped with red electrical tape **IS NOT** a temperature sensor. Do not factor these in when counting nodes above concrete or at splices



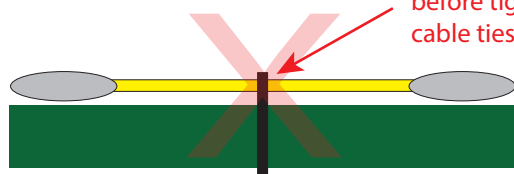
Proper Installation Method:

Allow slack in wire between nodes before tightening cable ties



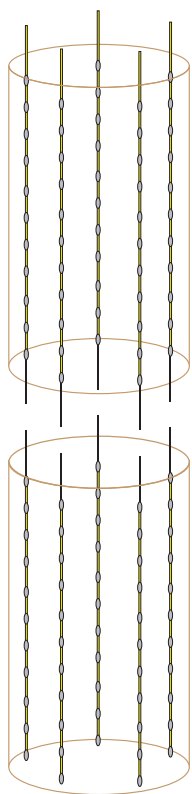
Improper Installation Method:

DO NOT apply tension in wires before tightening cable ties



Thermal Wire® Installation

Additional Information for spliced cages



In cage installs with multiple sections, the wires come with quick connect splices built in. In the field, correctly aligning and installing the splices is critical to data consistency. When the wire sections are joined together you will have extra nodes that are coiled up and will not be included in the measurements. It is critical to follow these steps and recommendations to get proper data and avoid having to re-install a wire.

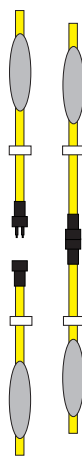
The key factors to keep in mind are:

- Offset & Overlap numbers for each splice.
- Keeping all wires correctly aligned vertically by node number.
- The total length of the sectioned wires must match the length programmed from the factory. The sections must be connected in the proper section-order as labeled at the factory.
- Labels on spools and wire sections contain information vital to keeping sets matched, protecting from potential loss of data.
- When routing cables in each section, make sure to pay attention to how the cage sections will go together and how it could effect the wire vertical alignment once they go together.

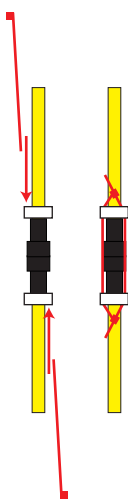
Be sure to follow all recommendations on wiring from the above Thermal Wire Installation section along with these recommendations for splices.

Connecting & Taping Splice

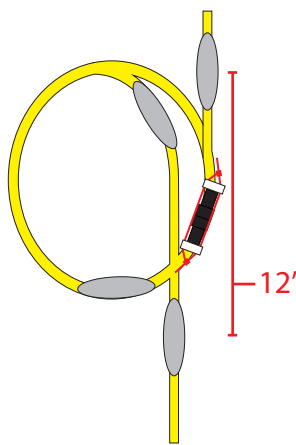
Connect the splice, push together until the male and female splice connectors are fully mated.



Slide the white clips at each splice snug against the connectors. Slide a cable tie through the clips on each side, one in one direction and the second in the opposite direction. Feed the end of each cable tie into the locking section of the opposite tie. Tighten them together until snug without bending the wire connection.



Coiling Excess Nodes



Once the connection is tied, coil up the extra nodes and cable tie them safely out of the way of potentially damaging installation processes.

Once the extra nodes are coiled make sure there is roughly 12" of space from the last node above the splice(Offset) to the first node below the excess coil.

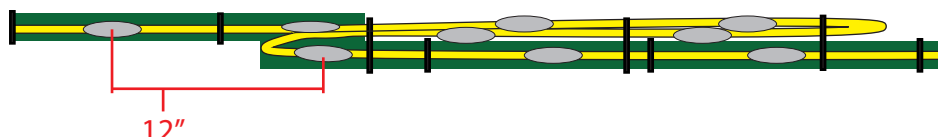
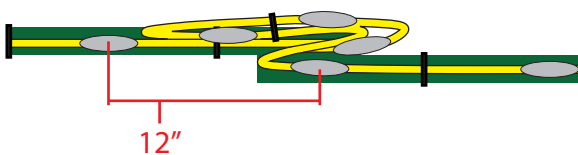
See Offset and Overlap next page.

Coiling Excess Nodes

When coiling up the excess nodes there are several ways to keep the excess wires out of the way and protected. The two methods below are recommended, but you can use any method that protects the wires from damage and enables you to easily keep track of the offset and overlap.

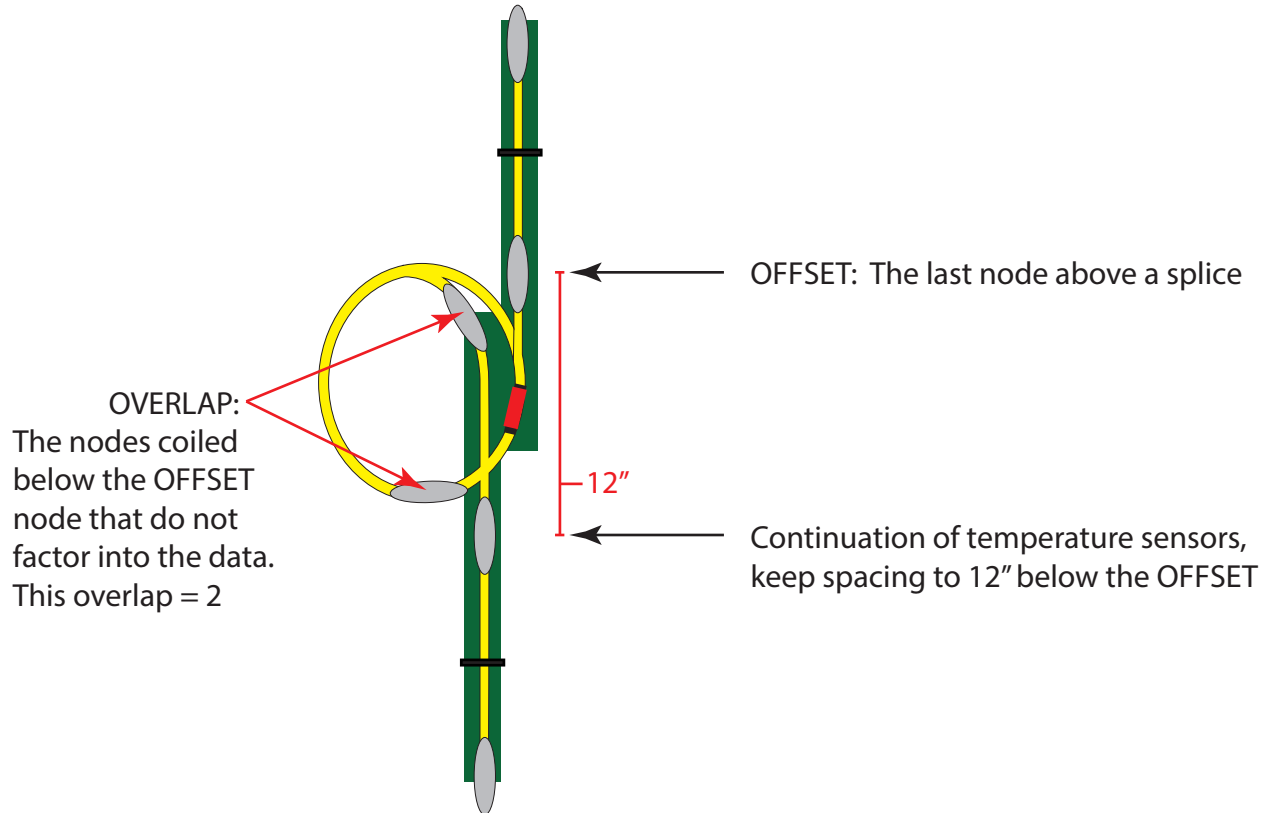
Tight coil bundled up and cable tied to bar.

Run excess wire up the bar and cable tie in place..



Offset & Overlap


Once the quick connect splices are joined and taped and the coil is bundled and zip tied in a safe position, determine the the offset and overlap numbers. Keep these numbers consistent between all wires on a shaft if possible.





Labeling

Both the wire spools and the wires themselves are labeled to aid in keeping the correct wire groups together.

Spool Labels, Sectioned Cable

 Thermal Wire® Cable	14625 PF		
	<small>S/n</small>		
Top60'-25L	1	of 3	165
<small>Section Description</small>	<small>Section</small>	<small>Sections</small>	<small>Cable Total Nodes</small>

 Thermal Wire® Cable	14625 PF		
	<small>S/n</small>		
Mid65'	2	of 3	165
<small>Section Description</small>	<small>Section</small>	<small>Sections</small>	<small>Cable Total Nodes</small>

 Thermal Wire® Cable	14625 PF		
	<small>S/n</small>		
Bot40'	3	of 3	165
<small>Section Descri</small>	<small>Section</small>	<small>Sections</small>	<small>Cable Total Nodes</small>

Wire Labels

Thermal Wire® 14625 PF 165' 25' Lead
--

At the Connector

Node: 60 of 165 Splice: 1

Bottom of Top section

Node: 61 of 165 Splice: 1

Top of Middle Section

Node: 125 of 165 Splice: 2
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Bottom of Middle Section

Node: 126 of 165 Splice: 2
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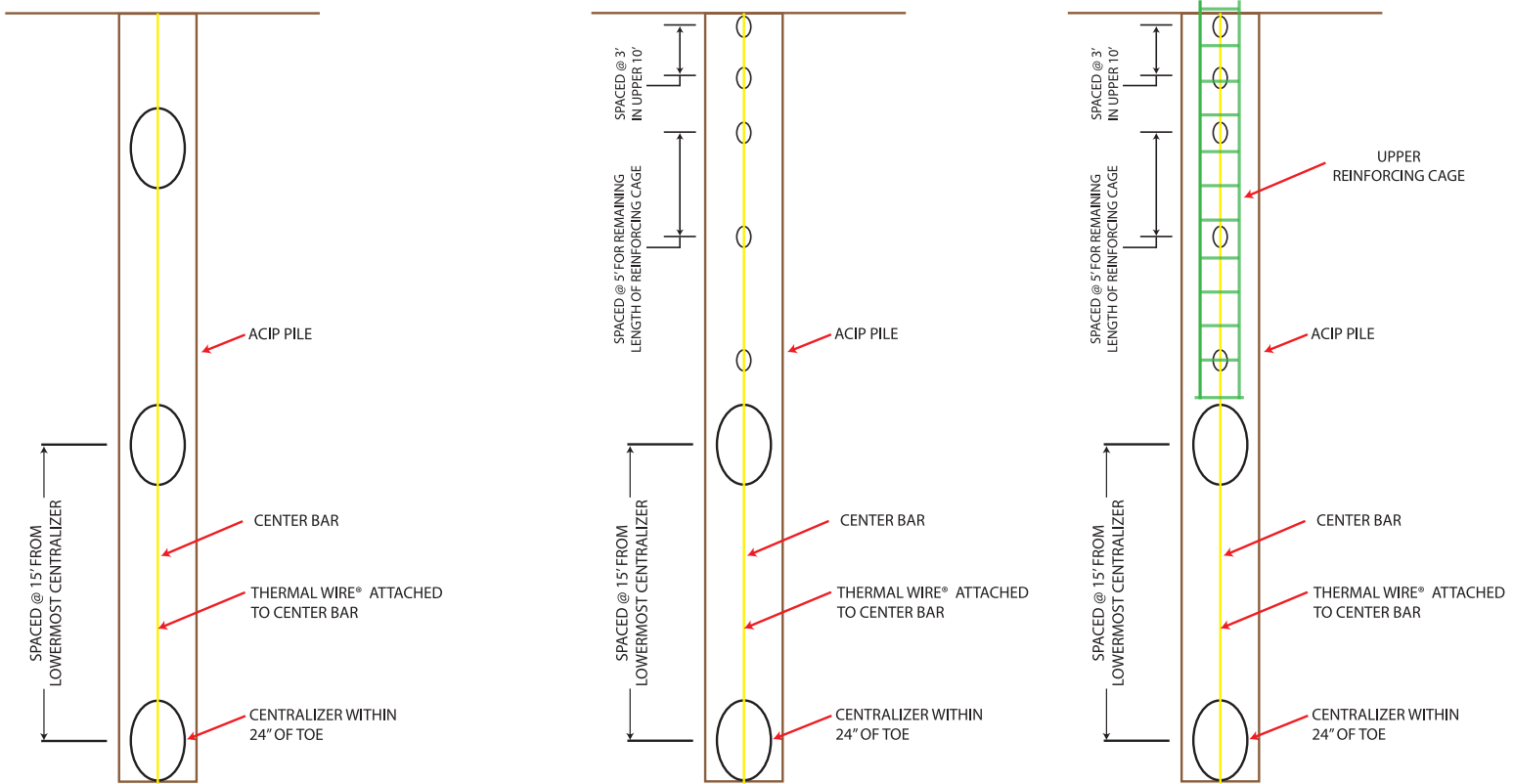
Top of Bottom Section

Thermal Wire® Installation Additional Information for Augercast Piles

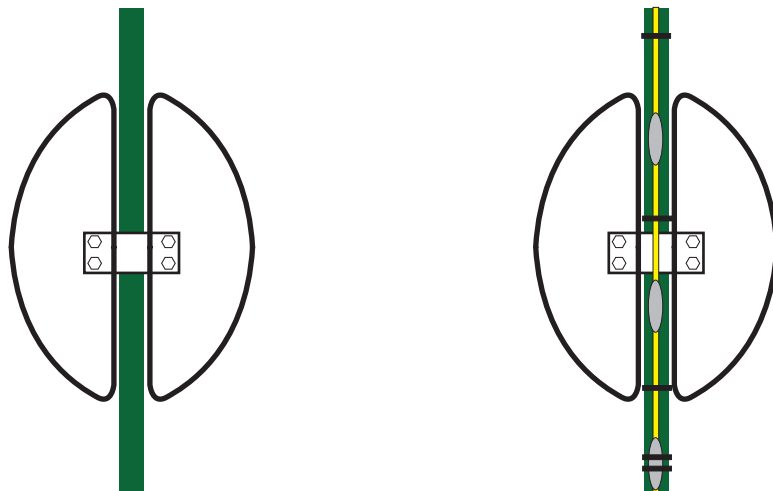
When using Thermal Integrity Profiling on ACIP piles it is important to take steps to centralize the center bar and protect the Thermal Wire® from the upper reinforcing cage if it is lowered into the pile after the center bar has been placed. Pile Dynamics recommends UniSpacer™ centralizers from Foundation Technologies in Atlanta, GA because they have bolt on connections that keep them from sliding along the bar after install. Centralizers that are attached with tie wire or cable ties typically slide along the bar and can damage the Thermal Wire® during bar placement. Part# US1618 is ideal for centralizing the center bar in the pile and custom part #US0400C is used to protect the wire when the upper cage is lowered over the center bar.

CENTER BAR INSTALLED WITHOUT REINFORCING CAGE

CENTER BAR INSTALLED WITH REINFORCING CAGE



When using UniSpacer™ centralizers, bolt the centralizers in place before running the Thermal Wire®.



Thermal Integrity Profiling: Wire Method – Quality Assurance Plan

I. Thermal Wire System

- Thermal Integrity Profiler – TIP Main Unit
- TAP (Thermal Access Port) Note: One TAP Box required for each embedded Thermal Wire® cable USB cable to attach TAP to TIP
- Thermal Wire® cables

II. Required Equipment

- Zip Ties to attach Thermal Wire® cable to cage
- Tape measure
- Snips to remove any temporary Zip Ties

III. Required Forms

- Thermal Field Log (included in TIP manual appendix)
- Concrete Log (with volume vs. depth measurements)
- Shaft Installation Records
- Relevant Boring Logs

IV. Procedures

- Verify correct date and time on TIP Main Unit– update time and time zone if necessary
- While coiled on the spool, verify each Thermal Wire® cable is operational by attaching to a TAP
 - i. Fast intermittent green light followed by slow green intermittent light indicates normal functionality
- Evenly space the wires around the perimeter of the cage and attach via zip ties to longitudinal bars.
- Avoid cage lift points and centralizers
 - ii. Avoid locations where inner cage supports will be removed during placement via torching
 - iii. Do not attach to CSL Access tubes
 - iv. Do not run the cable laterally or on an angle between longitudinal bars
- Generally, it is best to locate the cables on the “side” face of rebar 90° to the shaft diameter to avoid contact with the shaft wall and the tremie pipe
- Start at the top of the cage and unspool and feed the bottom sensor through the cage to the base
 - i. Do not attempt to pull the Thermal Wire® cable free if a sensor gets snagged during installation
- Position bottom sensor 1 to 3 inches from the bottom of the cage and affix with 2 zip ties
- Zip ties should be placed 1.5 inches above and below each sensor
- Start at the base and then fix the cable from the base of the cage to the top. Do not tension or pull all of the slack out of the cable. The cable should simply “lay” in position along the longitudinal bars. Pulling out all of the slack or tensioning the cable may result in damage.
- Coil any remaining sensors and cable at the top of the cage so it will be out of the way during installation
 - i. During concrete or grout placement, position the coiled section of wire on the outside of the cage to avoid contact with the tremie
 - ii. During the extraction of casings, position the coiled section of wire on the inside of the cage to avoid contact with the casing
- After affixing the wires to the cage, retest Thermal Wire® cables by attaching to a TAP Take preliminary data reading with the TIP Main Unit after placement
- If a TAP is flashing red try connecting another TAP to see if the issue persists
 - i. If possible, visually observe the cable for cuts or other damage
- Thermal Wire® cables should be connected to a TAP soon after placement is complete
- Leave the TAP connected until peak temperature is achieved, generally 12-48 hours depending on diameter Data may be collected and assembled without prior TIP Main Unit setup. When in doubt, connect the Thermal Wire® cable to a TAP and collect data during the hydration process.