**SAMPLE SPECIFICATION FOR THERMAL INTEGRITY PROFILING**

May 1, 2024

*The user of this sample specification should recognize that each project has unique requirements. The project foundation type and its installation procedures, geometry and reinforcement details should be considered in modifying this sample specification to address and satisfy project specific requirements. This sample specification includes commentary throughout to facilitate final specification development by the end user. Contractual items are limited since each owner, agency, or project has its own requirements and procedures.*

**1.0 DESCRIPTION**

Non-destructive testing shall be performed using the Thermal Integrity Profiler Wire Cable methodology, or equal, to provide analytical data for the entire shaft (cage and cover) radius. The Thermal Integrity Profiler (TIP) method uses the heat generated by curing cement (hydration energy) to assess the integrity or quality of Cast-in-Place concrete foundations such as Drilled Shafts, Bored Piles, Micropiles, Augered Cast-in-Place Piles, Continuous Flight Auger Piles, and Drilled Displacement Piles, herein referred to as “Shafts”. The expected temperature at any location is dependent on the shaft diameter, mix design, time of measurement, and distance to the center of the shaft. TIP measurements may be used to estimate the actual shape of the shaft. These estimates may be compared with concrete logs to assess the overall quality of the shaft. Because the method relies on the heat of hydration, TIP testing is generally done between 8 and 48 hours of concrete placement. Data is acquired via the Thermal Wire cables which are vertically zip tied to the rebar cage or center reinforcing bars prior to the concreting process.

***Commentary****: The optimum TIP testing time is dependent on shaft size and concrete mix and could range from 4 - 72 hours. Smaller shafts are typically tested earlier.*

**2.0 SUBMITTALS**

**2.1 Qualifications of the TIP Consultant.** The qualifications of the Consultant and the specifications for the equipment shall be submitted to the Engineer for approval prior to shaft installation. The TIP Consultant shall have a licensed professional Engineer supervising the testing and interpretation of results. The TIP Consultant shall be an independent testing agency with documented and approved experience in TIP testing.

**3.0 EQUIPMENT**

**3.1 TIP Equipment**. A Thermal Integrity Profiler (TIP), as manufactured by Pile Dynamics, Inc. (30725 Aurora Road, Cleveland, Ohio 44139, (216) 831-6131; [www.pile.com](http://www.pile.com)) shall be provided. The Equipment shall have the following minimum requirements:

1. A computer-based TIP Data Acquisition System to monitor and download temperature versus time after casting.
2. Ability to automatically collect data at user defined time intervals (typically 15 minutes).

**4.0 TESTING PROCEDURE**

**4.1 Shaft Preparation for Thermal Wire Cables.** Install (number, typically a minimum of four) evenly spaced Thermal Wire Cables in each (\_\_\_m, ft.) diameter shaft. Each shaft shall be equipped with Thermal Wire cables to permit integrity evaluation by TIP. The number of shafts to be tested by TIP is (number) or (percentage of all shafts)*.* Since the actual cost of the Thermal Wire Cables and data collection is very low compared to cost of the shaft, installing cables and collection data for all shafts is highly recommended. The shafts to be tested shall be chosen after installation by the Engineer.

***Commentary:*** *The actual number of Thermal Wire cables installed is typically designed as one Thermal Wire cable for every 10-14 in (0.25-0.35m) shaft diameter, with a minimum of 4 Thermal Wire cables. Shafts with different diameters at the same site may require a different number of Thermal Wire cables. The preferred even number of Thermal Wire cables allows for direct comparison of temperatures on diagonally opposite cables to evaluate cage eccentricity.*

**4.2 File Preparation for Testing.** Prior to TIP testing, the Contractor shall provide the Engineer and TIP Consultant with a record of all shaft lengths with elevations of the top and bottom, field volume logs, Thermal Wire Cable serial numbers installed with corresponding location in the shaft, and the installation date and times for all shafts.

**4.3 Test Procedure**. Thermal Wire Cables shall be connected to a Thermal Access Port (TAP Edge)and Thermal Aggregator (TAG) immediately following casting. Data shall be collected by the TAP at intervals of time specified by the Engineer (typically every 15 minutes) for a duration of time specified by the Engineer (typically 12-48 hours, depending on shaft diameter; often 24 hours is sufficient to reach the peak temperature)or as recommended by the TIP Consultant. In the event peak temperature is not reached within the specified time frame, the TAP Edge and TAG units shall remain connected to the Thermal Wire cables for a longer duration as directed by the TIP Consultant. During data collection, the TAG unit will send data wirelessly to the PDI Atlas Secure Cloud Server. The TAG will activate once per hour to send any data found in the TAP Edge units. If a wireless connection to the local signal cannot be achieved, the edge link cable can be plugged into the TAP Edge unit and data can be downloaded manually. Potential local anomalies indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths, shall be immediately reported to the Engineer.

**4.4 Contractor Assistance.** The Contractor shall provide cooperative assistance, suitable access to the site and shafts to be tested, and labor as required to assist the TIP Consultant in performing the required tests. The Contractor shall coordinate with TIP Consultant and install the necessary TIP instrumentation prior to concreting the shaft. Thermal Wire Cable installation requirements are detailed elsewhere in this specification. Prior to TIP testing, the Contractor shall provide the shaft lengths, wire positions, the shaft construction date, shaft construction inspection record, and concrete placement details to the TIP Consultant. The Contractor responsible for installing the Thermal Wire cable assemblies shall be required to obtain training from the Manufacturer on proper installation practices prior to actual installation.

**5.0 ANALYSIS AND REPORTING**

Results by the TIP shall be presented in a written report within 5 working days of completion of the testing. The report shall present results of TIP tests by including:

1. The final analysis must include top of shaft and bottom of shaft adjustments per the manufacturer’s recommendations, so that the temperature plots are adjusted for end effects.
2. Graphical displays of all temperature measurements versus depth.
3. Indication of unusual temperatures, particularly significantly cooler local deviations of the average at any depth from the overall average over the entire length.
4. The overall average temperature. This temperature is proportional to the average radius computed from the actual total concrete volume installed (assuming a consistent concrete mix throughout).Radius at any point can then be determined from the temperature at that point compared to the overall average temperature.

**5.1 Variations in Temperature.** TIP measurements that are cooler than normal indicate inclusions, necks, or poor quality concrete; while warmer than normal measurements are indicative of bulges outside of the cage diameter. Variations in temperature between diagonally opposite pairs of Thermal Wire Cables reveal cage eccentricities, such as cage misalignment. Variations in temperature between Thermal Wire Cables (at each depth)which in turn correspond to variations in cage alignment.

***Commentary****: Where concrete volume is known the cage alignment, or offset from center, should be noted.*

**6.0 BASIS OF PAYMENT**

The completed TIP results and report shall be paid for at the contract bid price for “Thermal Integrity Profiling” (for each shaft, per linear meter or foot, or per day of testing). This shall constitute full compensation for all costs incurred and relating to the TIP testing including, but not limited to, procurement, preparation, and installation, conducting the tests, and subsequent reporting of results.

***Commentary****: Payment for Thermal Wire cable data collection is dependent on the TIP Consultant’s involvement with the process. If the TIP Consultant is on site to personally collect data, the “per day of testing” basis is considered the most equitable. If the data is sent electronically to the TIP Consultant the “per shaft tested” basis may be more equitable. If a “per shaft” basis is required for a Thermal Wire cable project, and the project has variable shaft lengths and diameters, then multiple pay items should be created for each group of shafts with similar nominal diameters and lengths.*