

**SAMPLE SPECIFICATION for INSTALLATION of  
AUGERED CAST-IN-PLACE, CONTINUOUS FLIGHT AUGER  
or DRILLED DISPLACEMENT PILES  
USING AUTOMATED MONITORING EQUIPMENT**

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The contractor shall provide an Automated Monitoring Equipment such as a **Pile Installation Recorder** (PIR) or equivalent for each piling rig. The PIR shall record appropriate information during both the augering phase and the grouting phase of the installation to assure a minimum grout volume is pumped per unit depth increment, and shall print the results immediately upon completion of each pile and/or during reprocessing with dedicated report preparation software. The PIR (available from Pile Dynamics, Inc., 30725 Aurora Road, Cleveland, OH 44139, USA; [www.pile.com/pdi](http://www.pile.com/pdi); email: sales@pile.com; phone: +1 216-831-6131; fax +1 216-831-0916,) shall have the following minimum components:

1. **PIR Display Unit** shall display numerically and/or graphically the information from all sensors, print results on-site in (\_\_\_\_, English or SI) units, and store information on an internal memory storage device. Unit shall have an easy-to-use touch-screen interface and shall provide immediate feedback to the operator, particularly during the critical grouting phase to assure minimum grout volume per depth increment.
2. **Depth Sensor** shall track the movement of a spring tensioned wheel mounted from the gearbox to the auger leads, and always held in tension against the auger leads to measure the auger top position (and thus auger tip). Depth shall be set to zero when the auger tip is touching the ground surface. The maximum pile depth (from ground elevation) shall be recorded. An alternate configuration is a cable attached to the drill top to measure auger top (and thus auger tip) location at all times during installation.
3. **Magnetic Flow Meter** (MFM) shall be installed in the grout line to measure grout volume pumped within an accuracy of  $\pm 2\%$ .
4. **Field Printer** shall record a hard copy of results for each pile including incremental augering times, incremental grout volumes, and summary grout volumes. Printed results shall be provided to the Engineer or Inspector immediately following completion of each pile installed.
5. **Grout Pressure Sensor** (optional) shall monitor and records grout line pressure. Although not used to evaluate incremental volume, this sensor may also count pump strokes. The MFM total volume and total pump strokes allows computation of volume per pump stroke to evaluate consistency of grout pump performance and alert the field crew if pump maintenance is needed.
6. **Torque Pressure Sensor** (optional) shall monitor crane torque during augering. Keeping this pressure below but near the maximum pressure allowed by the crane reduces stalling the crane and improves overall drilling and production efficiency.
7. **Proximity Switches** shall measure auger rotation in RPM

The auger tip depth and drilling rate (ft/minute or m/minute) shall be displayed during drilling.

Volume pumped per unit depth increment shall be displayed to the crane operator graphically as a bar chart with the minimum grout ratio clearly displayed as a guide. A depth increment of \_\_\_\_ {typically 2 ft or 0.5 m} for grouting shall be selected so that a minimum of \_\_\_\_ {e.g. 5} or more strokes are required per increment. The MFM and Depth Sensor information are sufficient to determine volume pumped per unit depth increment.

A printout shall be provided immediately upon completion of each pile. The printout shall be inspected prior to moving the rig, and if the grout pumped falls below the specified allowable minimum grout ratio

for any depth increment, the pile shall be re-augered to \_\_\_ {e.g. 5 ft or 1.5 m} past the defect and re-grouted while the grout is still fluid. The specified minimum grout ratio of \_\_\_ {e.g. 115%} may be adjusted by the Engineer based on observed grout return depths and PIR grout installation records. It shall be possible to review, summarize and plot field data with dedicated software such as PIRPLOT (available from Pile Dynamics, Inc.) or equivalent.

The PIR shall be installed prior to construction of the piles, and shall be maintained during the execution of all production piles unless otherwise directed by the Engineer. In the unlikely event that the unit is not fully operative, the Contractor shall notify and work with the manufacturer to rectify the situation. During the brief period while the situation is being rectified, as directed by the Engineer, the Inspector shall manually record incremental volume until the unit is fully operative.

The PIR does not replace the Inspector but rather assists the Inspector during the critical grouting phase by accurately monitoring grout pumped versus depth. The Inspector shall still observe and record arrival times of grout trucks, obtain grout samples, pile location versus planned location, grout return depth, reinforcement bar placement, excavation and other unusual activities or installation information as directed by the Engineer. The Inspector shall collect PIR printouts for each pile installed and transmit them to the Engineer \_\_\_ {e.g. daily, or at a frequency determined by the Engineer}.