

SECTION 02380
FOUNDATION PILES

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division I Specification Sections, apply to this Section.
- B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this Section.
- C. Coordinate work with that of all other trades affecting or affected by the Work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.2 DESCRIPTION OF WORK

- A. The Work of this Section includes, but is not limited to, furnishing all labor, materials, equipment, and incidentals necessary to complete the following work:
 - 1. Furnishing and installing the following types of end-bearing steel H-piles at the locations shown on the Drawings: XXX-kip allowable design compression capacity XXXXX be driven to a minimum XXX-kip ultimate capacity.
 - 2. Conducting computer wave equation analyses by WEAP (Wave Equation Analyses for Piles) prior to mobilization and import of pile materials to the site to demonstrate that: (a) the proposed hammer and driving system delivers the required energy per blow to the pile and that driving stresses in the piles with the proposed hammer-pile-soil systems will not exceed the allowable tensile and compressive stresses of the piles during driving; and (b) for Contractor-proposed alternate hammer-pile-soil systems to confirm or determine end-bearing driving criteria to achieve allowable design compression capacity of the pile (as stated above).
 - 3. Installing indicator piles at designated production pile locations and performing Dynamic Pile (PDA) Testing on all of the indicator piles at locations shown on the Drawings. PDA testing

shall be conducted prior to the start of production pile driving to evaluate the driving energy transferred to the pile during installation, stresses induced in the piles during driving, anticipated pile lengths, and performance of the pile driving equipment. Indicator piles are to be driven at a minimum of XXX (X) designated production pile locations.

4. Perform CAPWAP analyses on a minimum of three of the indicator piles at locations determined by the Geotechnical Engineer.
5. Installing production piles based on the WEAP analyses and the results of the dynamic testing.
6. Cutting off piles at design cut-off elevations and disposing pile cut-offs at approved off-site locations. Preparing the exposed end of the pile to receive the structural connection to the floor slab and/or pile cap.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section XXXXX
- B. Section XXXXX
- C. Section XXXXX
- D. Section XXXXX

1.4 DEFINITIONS AND REFERENCE STANDARDS

- A. Owner: XXXXX
- B. Architect: XXXXX
- C. Structural Engineer: XXXXX
- D. Geotechnical Engineer: Haley & Aldrich, Inc., Portland, Maine
- E. Engineer: Authorized representatives of the Architect or Owner. For the work covered under this Section, this term will include Haley & Aldrich, Inc.
- F. Contractor: Person or organization identified in the Agreement as being responsible for the Work under this Section. The term Contractor shall also refer to an authorized representative(s) of the Contractor.
- G. ASTM: Specifications of the American Society for Testing and Materials, latest edition.

- H. AWS: AWS D1.1 Structural Welding Code - Steel, latest edition.
- I. AISC: Specification of the American Institute of Steel Construction, latest edition.
- J. AASHTO: Specification of the American Association of State Highway and Transportation Officials, latest edition.
- K. ACI: Specification of the American Concrete Institute, latest edition.
- L. PCI: Specification of the Prestressed Concrete Institute, latest edition.
- M. OSHA: Occupational Health and Safety Administration.
- N. IBC Code: International Building Code (2003 edition).

1.5 PROJECT CONDITIONS

A. Site, Subsurface Soil, and Groundwater Conditions

1. Subsurface investigation data are available from the Owner in the report entitled "Report on Subsurface Explorations and Foundation Design Recommendations, Eastern Waterfront Development Proposed Parking Garage and Office Building, Portland, Maine," prepared by Haley & Aldrich, Inc., dated 08 November 2005.
2. Refer to Section XXXXX for additional information.

B. Potential Obstructions

1. The Contractor is advised that the fill soils at the site may contain obstructions, which may include, but are not limited to former and existing utilities, concrete and other foundations and floor slabs from previous structures, and other materials which may interfere with new foundation locations and require removal. The Contractor shall notify the Geotechnical Engineer immediately if conditions are determined to conflict with proposed pile locations.
2. Obstructions are defined as any man-made objects located within 15 ft of existing ground surface that prevent installation of new piles at the design locations and to the required depths.
3. Pre-drilling of foundation piles may be required at pile locations prior to pile installation as described herein. Work associated with removal and backfill of obstructions by use of powered

excavators will be performed by others. The Contractor shall pre-drill where necessary to clear underground structures and obstructions prior to pile installation. Pre-excavations shall be backfilled and compacted in a controlled manner prior to pile installation in accordance with Section XXXXX using on-site fill materials with objects larger than 4 in. removed.

C. Review of Existing Information:

1. Prior to submitting a bid, the Contractor shall review and understand the information contained in the referenced reports, Contract Documents, and other applicable resources. The referenced reports are made available to the Contractor for information only. The subsurface and environmental conditions information presented in these documents, as applicable, are for information only and shall not be interpreted as a warranty of subsurface or environmental conditions whether interpreted from written text, boring logs, chemical test results, or other data.
2. The Contractor shall draw its own conclusions regarding site conditions based upon site visit(s) and from available sources, for which the Owner and its consultants assume no responsibility. The Contractor shall assume that subsurface conditions between subsurface explorations could differ from conditions shown in the records of the explorations.

D. Protection of Adjacent Property and Utilities:

1. The Contractor shall protect adjacent structures (above ground and buried) from damage associated with pile driving and other related operations. Damage due to pile driving or other construction activities shall be repaired immediately by the Contractor at its own expense.

1.6 QUALITY ASSURANCE

- A. Comply with all rules, regulations, laws and ordinances of the State of Maine, City of Portland, OSHA and of all other authorities having jurisdiction. All labor, materials, equipment, permits and services necessary to make the work comply with such requirements shall be provided by the Contractor.
- B. Field Monitoring and Testing:

1. In accordance with the requirements of the IBC Code, the Geotechnical Engineer will provide full-time monitoring of the Contractor's pile driving operations. No piles shall be driven except in the presence of the Geotechnical Engineer.
 2. The Geotechnical Engineer will prepare and maintain pile driving records which include the following information:
 - a. Project name and number.
 - b. Name of Contractor.
 - c. Pile location and number.
 - d. Design pile capacity.
 - e. Type and size of hammer used.
 - f. Material type, dimensions, and thickness of any pile driving cushion between the hammer and pile.
 - g. Rate of operation of pile driving equipment.
 - h. Pile dimensions.
 - i. Elevation of tip.
 - j. Elevation of butt before and after cut-off.
 - k. Ground elevation.
 - l. Number of blows for each foot of penetration and final penetration resistance.
 - m. Pile location deviation.
 - n. Pile uplift and redrive information.
 - o. Unusual occurrences during pile driving.
- C. The Contractor shall fully cooperate with the Geotechnical Engineer and the Owner's other representatives to facilitate other work.
- D. Certification of quality and source of pile materials to be used in the work shall be furnished, in a form acceptable to the Geotechnical Engineer, at the time of delivery of materials to the site. Pile materials shall also be subject to on-site inspection by the Geotechnical and/or Structural Engineer for conformance with specifications.
- E. Approvals given by the Geotechnical Engineer or Owner shall not relieve the Contractor of its responsibility for performing the work in accordance with the Contract Documents, nor shall they be construed to relieve the Contractor from its full responsibility for the means and methods of construction and for safety on the construction site.
- F. The Contractor shall employ a Professional Engineer registered in the State of Maine who specializes in geotechnical engineering to perform WEAP Analyses for all pile driving systems and types of piles, to conduct

PDA testing, and to perform related CAPWAP analyses. The Registered Professional Engineer shall have not less than 5 years experience within the last 10 years in making consulting engineering recommendations, design, or supervising installation of pile foundations, and shall have completed WEAP analyses, PDA testing and CAPWAP analyses on not less than five unrelated, independent projects, in which piles were successfully installed using the pile driving criteria developed from the wave equation analyses and the load test results.

G. Qualifications of Contractor:

1. Shall have at least 3 years experience within the last 10 years in pile driving of similar type and complexity as the indicated pile foundations.
2. Shall have completed not less than 3 successful pile foundations of similar type and complexity as the indicated pile foundations within the last year.

H. All welding shall be performed by operators who have been previously qualified by tests as prescribed in the "AWS Standard Code for Welding in Building Construction". Evidence that welders meet qualification requirements shall be submitted to the Geotechnical Engineer before welding has begun. Monitoring of welding and welds may be performed by an independent testing agency employed by the Owner. The Contractor shall fully cooperate with the agency to facilitate inspection, notifying it at least one working day in advance when welding operations are to be performed. Welds that do not conform to applicable specifications shall be repaired as directed by the Owner or its authorized representative.

1.7 SUBMITTALS

A. General:

1. The Contractor shall submit the information specified herein to the Geotechnical Engineer for review. All submittals and data shall be legible, provided in English, and stamped by a Professional Engineer registered in the State of Maine and retained by the Contractor.
2. The Contractor shall adhere to the approved submittal schedule, making every effort for timely submissions and allowing adequate time for the Geotechnical Engineer to review, evaluate and respond to the Contractor. The Contractor is responsible for scheduling specified submittals

and re-submittals so as to prevent delays in the work.

3. Unless otherwise specified, submittals shall be made not less than three weeks before the start of the work. No work shall be started until the necessary review and approvals have been given.

B. Shop Drawings:

1. Shop Drawings showing pile sizes, pile tip and splice details, reinforcing, and other items pertinent and as applicable to particular pile design and handling.
2. Shop Drawings and design calculations for all items pertinent to pile manufacturing and handling/installation.
3. Shop drawing showing pile layout and pile numbering.

C. Pile Driving and Dynamic Load Test Equipment:

1. Manufacturer's literature, including technical and performance literature for pile driving hammer(s), cushions, hoses, and other equipment for piles.
2. Details of equipment and procedures for pre-excavation and pre-drilling.
3. Qualifications and experience of Contractor's Professional Engineer performing the PDA testing and CAPWAP analyses.
4. Description of dynamic testing equipment and procedures.
5. Complete reports of PDA measurements/analyses and CAPWAP analyses performed during the indication pile program at least three working days prior to the commencement of the scheduled production pile driving.

D. Pile Design/Manufacture:

1. Name and address of pile manufacturer/supplier.
2. With each delivery of steel piles and steel reinforcing, mill certificates containing results of material tests conducted by a certified laboratory, including the chemical composition, yield point and ultimate strength of the steel. The Owner may reject any delivery of steel materials that is not accompanied with applicable mill certificates.

E. Wave Equation (WEAP) Analyses:

1. Qualifications and experience of Contractor's Professional Engineer performing the WEAP analyses.
2. The Contractor shall propose final driving criteria (blow count) as the minimum number of hammer blows for each inch of the final 6 in. of pile penetration in the bearing stratum. The proposed criteria shall be submitted to the Geotechnical Engineer for review and acceptance. Piles shall not be installed prior to acceptance of the criteria by the Geotechnical Engineer.
3. Results of WEAP analyses, performed and stamped by a Registered Professional Engineer in the State of Maine, which demonstrate that the equipment, cushions and cap are capable of obtaining the required pile load capacity in accordance with the IBC Code without damage to the particular pile type due to driving stresses. The WEAP analysis shall model bearing conditions in soil and bedrock, and anticipated pile lengths across the site and at a minimum shall consider XXXXX and XXXXX pile types. The submittal shall also include any additional applicable assumptions used in the analyses.
 - a. Analyses over a range of final pile penetration resistance, from X to XX blows per inch.
 - b. The minimum allowable toe quake used in the analyses shall be X.XX.
 - c. The minimum allowable toe damping used in the analyses shall be X.XX.
 - d. The maximum allowable compressive stress in the pile during driving shall not exceed XX percent of the steel yield strength.
 - e. The maximum allowable tensile stress in the pile during driving shall not exceed XX percent of the steel yield strength.
 - f. The minimum resistance from the pile tip shall be XX percent.
 - g. The hammer efficiency shall be selected based on the wave equation program default for the selected hammer.
4. Prior to installing indicator piles, submit a tabular summary of anticipated indicator pile lengths. The tabular summary shall include pile designation and estimated length as determined from the anticipated tip elevation and cutoff elevation. Within five days after completion of driving indicator piles, submit a tabular summary of anticipated pile lengths at each column location or other point of structure support.

F. Pile Dynamic (PDA) Testing:

1. Report summarizing the results of the PDA testing conducted by the Contractor's Engineer.

G. As Driven Pile Location Data:

1. Submit final as driven pile location plan, certified by a Registered Land Surveyor, within 2 weeks of completion of pile driving.

1.8 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Refer to General provisions of the Contract Documents for requirements pertaining to Product Delivery, Storage and Handling.
- B. The Contractor shall deliver piles at approved times and in sequence to assure continuity of pile driving.
- C. Piles shall be handled, transported, stacked, and protected to prevent damage.
- D. Piles shall be clearly marked with the length of the pile prior to delivery.

1.9 LINES AND GRADES

- A. The Contractor shall stake the pile locations and establish all elevations required. A baseline and benchmark located on or close to the site will be provided by the Owner. The Contractor shall be responsible for the maintenance and protection of the baseline and benchmark, and all pile location stakes.
- B. The Contractor shall employ a licensed Registered Land Surveyor, familiar with pile installation, who shall establish lines and levels. The Contractor shall be responsible for the correct location of piles, as well as keeping up to date records of the amount of uplift of individual piles, and establishing actual pile locations.
- C. Within two weeks after the completion of all pile driving, the Contractor shall provide for the Engineer a plan, certified by said Surveyor, showing the as driven location of all piles. Drawings shall include the following:
 1. Column lines and north arrow.
 2. Each pile identified by a separate number.

3. Elevation of each top of pile prior to cutting, to nearest 0.1 foot.
4. Deviation in inches, to the nearest one fourth inch, from plan location at cutoff elevation.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Pile materials shall be new and of uniform quality. Manufactured or assembled pile materials shall be of sufficient strength and rigidity to withstand all driving stresses.
- B. Length of piles to be ordered shall be determined by the Contractor. Ordering, delivery and use of piles shall be planned and performed in such a manner that minimizes delays or interruption of driving and precludes the need for splices.

2.2 STEEL H-PILES

- A. Steel H-piles shall be Grade 50, having a minimum yield point of 50,000 psi. Accompanying certificates shall state the chemical composition and yield point of the steel. The piles shall be identified to permit rapid correlation with the appropriate mill certificates.
- B. H-piles shall be of sufficient strength and rigidity to withstand all driving and handling stresses and to maintain initial shape within the tolerances specified hereinafter. Pile materials shall be new and of uniform quality.

2.3 SPLICES

- A. Full length piles shall be used wherever practicable.
- B. If full length piles cannot be used, only one splice per pile shall be allowed.
- C. A full penetration butt weld shall be used for the entire cross-section of the pile.
- D. Welding shall not be done when the temperature in the immediate vicinity of the weld is below 0°F, when the surfaces are damp or exposed to rain, snow or high wind, or when the welders are exposed to inclement weather.
- E. The pile shall be preheated to and maintained at 150°F minimum within 6 in. of the weld during welding.

F. The maximum electrode size shall be 3/16 in.

2.4 Pile Tip/Driving Shoe

A. Fit and weld cast steel, prefabricated pointed pile tip to tip of pile with a 5/16-in. groove weld or equivalent along each flange. Welding shall be performed as outlined herein.

2.5 Pile Length Markings

A. Permanently mark the entire length of each pile with horizontal lines (perpendicular to long axis of pile) measured from the pile tip at 12-in. intervals. In addition, footage shall be marked and designated at 5-ft intervals, starting from the tip of the pile.

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS AND EQUIPMENT REQUIREMENTS

- A. Prior to production pile installation, the Contractor shall drive a minimum of X indicator piles at production pile locations, at the locations shown on the Drawings. The Contractor's Engineer shall perform dynamic (PDA) testing during installation of each indicator pile to aid in estimating the required pile lengths and to evaluate hammer performance, acceptable driving stresses, and to confirm the final driving criteria based on the measured hammer energy transferred to the pile. Depending on the results of the PDA testing the Geotechnical Engineer may adjust indicator pile locations.
- B. The Contractor shall coordinate its pile installation operations with other work on the site.

3.2 PILE DRIVING CRITERIA

- A. The Contractor shall furnish and install H-piles to depths within glacial till or bedrock and to the approved final penetration resistance that will develop the required design compression capacity as specified herein.
- B. Contractor shall drive piles to not less than an approved final penetration resistance over the final 6 in. of driving as determined by the WEAP analyses and confirmed by the PDA testing.
- C. To limit the potential for overstressing of the pile during driving, if less than 1/2 in. of penetration is achieved under 10 successive hammer blows, driving

should be stopped and the pile shall be evaluated by the Geotechnical Engineer in accordance with requirements of the "Obstruction" paragraph specified herein.

3.3 INDICATOR PILE INSTALLATION

- A. XX indicator piles shall be driven by the Contractor using the proposed pile driving equipment to the final driving criteria identified herein and as supported by the Contractor's approved WEAP analyses.
- B. Indicator piles will consist of both XXXXX and XXXXX pile sizes.
- C. No piles shall be driven except in the presence of the Geotechnical Engineer.

3.4 DYNAMIC PILE (PDA) TESTING

- A. During driving of the indicator piles, the Contractor's Engineer shall conduct PDA testing on all indicator piles to evaluate the performance of the hammer/pile driving system, calculate stresses in the pile during driving, assess the structural integrity of the pile, and evaluate pile capacity/pile driving criteria. The Contractor's Engineer shall perform CAPWAP analyses on three of the piles as selected by the Geotechnical Engineer. CAPWAP shall be performed on both XXXXX and XXXXX piles.
- B. The Contractor shall plan adequate time for PDA testing to be performed during driving of the indicator piles.
- C. If based on the results of the PDA testing, the Geotechnical Engineer determines the hammer is not working adequately, the hammer will be repaired or replaced by the Contractor at no additional cost to the Owner. In this instance, the Contractor shall redrive all previously driven piles and possibly additional indicator piles and repeat the dynamic testing, as required by the Geotechnical Engineer, at no additional cost to the Owner.
- D. If, at any time during production pile driving, the Contractor proposes to change the pile installation equipment (including the individual hammer or hammer type) from that used to install the indicator piles, PDA testing shall be performed by the Contractor's Engineer at the Contractor's expense to confirm that the new hammer can transfer the minimum required energy to the pile and that pile stresses are within

acceptable limits. Dynamic testing of a minimum of an additional X piles will be required in this case.

3.5 PRODUCTION PILE INSTALLATION

- A. Piles shall be installed with approved modern equipment in good working order. The proposed pile installation equipment and methods shall be subject to approval of the Geotechnical Engineer and approval shall be secured before the start of installation.
- B. The leads of the pile driving rig shall be fixed at two points; the points shall be at least half the length of the leads apart in order to maintain the pile and hammer in axial alignment at the correct plan location during the entire driving operation. The leads shall extend down to the lowest point at which the hammer must operate.
- C. At the Contractor's option, an approved vibratory hammer may be used to install piles through overburden soils (i.e., fill, organic deposits, marine clay) into glacial till or to the top of bedrock. If piles are initially installed using a vibratory hammer, impact driving to final bearing shall be completed within four hours of the vibratory advance.
- D. Piles shall be driven with a single-acting, double-acting, or differential-acting steam, hydraulic, air, or diesel hammer as approved based on the WEAP analyses, PDA testing and CAPWAP analyses. When the determination of the final driving resistance is being made, the steam, hydraulic, air or diesel hammer shall be operated at a speed not less than 95 percent of the maximum blows per minute for which the hammer is rated by the manufacturer. The Contractor shall maintain the boiler or air pressure recommended by the manufacturer and shall employ the proper size hose and connections. When the determination of final driving resistance is being made with a diesel hammer, the energy being delivered to the pile shall be determined as the product of the weight of the ram times the observed or equivalent stroke for open diesel hammers; for closed diesel hammers, the energy shall be that indicated by an output gauge calibrated to measure total hammer energy. The Geotechnical Engineer will monitor hammer performance of an open-ended diesel using a saximeter which measures the rate of hammer operation.

- E. Special Requirement for Diesel Hammers: In the case of a diesel hammer, the Contractor shall provide an apparatus approved by the Geotechnical Engineer to measure gas pressures inside the hammer and total hammer energy for closed hammers, or ram bounce height in the case of open hammers.
- F. An aluminum micarta cushion block, or other cushion material consistent with WEAP analyses and PDA testing and if approved by the Geotechnical Engineer, shall be used in the hammer for driving piles. Cushions shall be replaced when burned or otherwise worn.
- G. Hammers used to install production piles shall be the same physical equipment used to install the indicator piles.
- H. The use of followers will not be permitted unless authorized in writing by the Geotechnical Engineer.
- I. Piles shall be installed systematically such that XXXXX piles are installed at indicated locations and are not mixed with XXXXX. The Contractor shall replace or supplement any piles that are misplaced by size as required by the Structural Engineer.
- J. Piles that are unsatisfactory as installed shall be removed, or repaired at no additional cost to the Owner.
- K. Pre-drilling:
1. As directed by the Geotechnical Engineer based on the results of the indicator pile program, the Contractor shall perform pre-drilling at production pile location to a minimum depth of 15 ft. Pre-drilling shall consist of drilling a 15-in. minimum diameter hole, using rotary augers. If pre-drilling is needed, the Contractor shall submit details of the equipment and methods to the Geotechnical Engineer for approval.
 2. Piles shall be installed to the full depth of the hole immediately after completion of pre-drilling.
 3. If the Contractor elects to pre-drill to greater depths, it will be considered incidental to its work, at no additional cost to the Owner. Deeper pre-drilling shall be subject to approval by the Geotechnical Engineer.
- L. Driving:
1. As part of preparation for driving, each pile shall be marked as specified herein.

2. All piles shall be driven at the indicated locations and orientations. The Contractor shall utilize a pile alignment system such as templates or other measures to position the piles at the correct location. Pile location and orientation shall be checked during driving and appropriate measures taken, as necessary, to maintain the correct pile position.
3. Each pile shall be driven to end-bearing into the glacial till or bedrock (below the marine clay) to a minimum ultimate capacity (compression) of XXX kips (XXX-kip allowable design capacity) for XXXXX piles, and to a minimum ultimate capacity of XXX-kips (XXX-kip allowable design capacity) for XXXXX piles.
4. Pile driving shall be continuous and without interruption for the final 5 ft of penetration. If pile driving is interrupted during the final 5 ft of driving, the Geotechnical Engineer shall be the sole judge of whether the pile driving resistance is impacted by frictional resistance above the bearing stratum.
5. Pile driving resistance shall be constant or increasing during achievement of the final driving criteria.
6. During pile driving, the maximum compressive and tensile stresses in the piles shall not exceed 90 percent of the steel yield strength.
7. When driving piles through soft soils or in pre-drilled holes, the hammer ram velocity at impact shall be reduced to avoid damage of the pile due to tensile stresses in the piles.
8. Immediately after a pile in a pile group is driven, the Contractor will establish a reference point and its elevation on the pile for the purpose of checking uplift (heave) of the pile tip as additional piles are driven.
9. After all piles within the radius of uplift have been driven, the Contractor shall determine the elevation of the reference points on each of the piles in the group. If uplift of 0.04 ft or more has occurred, the pile shall be redriven to its original elevation, and deeper if necessary, to the specified final driving resistance. After redriving each pile, the Contractor will re-establish the elevation of the reference point. Redriving shall be repeated as often as necessary until the measured uplift on any pile is less than 0.04 ft.
10. The radius of uplift shall be initially assumed to be 30 ft. This radius may be expanded or contracted by the Geotechnical Engineer based on actual field measurements and is defined as the

maximum distance between piles such that pile driving causes uplift of 0.04 ft or more in the affected pile.

11. Piles in a group shall be driven commencing at the edge of the group and working toward the opposite edge. All piles in any one group shall be driven before moving to other locations, unless otherwise acceptable to the Geotechnical Engineer.

M. Obstructions:

1. The Contractor shall make reference to the test boring logs, available plans and other information (e.g. Historic Sanborn Maps) showing the site conditions. The Contractor is advised that obstructions are present.
2. Obstructions, if encountered, shall be dealt with as follows:
 - a. Obstructions shall be defined as former and existing utilities, concrete and other foundations, floor slabs from previous structures and other man-placed material which prevent pile installation. Naturally occurring cobbles and boulders encountered at depths greater than 15 ft below existing ground surface will not be considered obstructions.
 - b. If a pile is obstructed as defined herein, the Contractor shall immediately notify the Geotechnical Engineer who shall determine whether the location is to be excavated or if the pile(s) shall be moved or additional piles installed. If directed by the Geotechnical Engineer, the Contractor shall attempt to remove and redrive undamaged, obstructed pile(s), after the obstruction has been removed, at no additional cost to the Owner.

N. Vibration Control:

1. Limit pile-driving induced ground vibrations (maximum peak particle velocity) to less than 0.5 in./sec at all nearby buildings, as measured by the Geotechnical Engineer.
2. If pile-driving induced vibrations exceed the level specified above, the Contractor shall adapt and modify pile driving procedures and equipment to limit vibrations below the specified level, at no additional cost to the Owner.
3. Vibration monitoring will be performed by the Geotechnical Engineer as necessary to determine compliance with this criterion.

O. Cutting Off Piles:

1. Pile tops shall be cut off square and within 1 in. of the elevations shown on the Drawings. The pile cut-offs shall be stockpiled in a designated area of the site and shall be removed from the site by the Contractor at no additional cost to the Owner.
2. If piles are driven below the design elevation and can not be satisfactorily built-up in the opinion of the Structural and Geotechnical Engineers, these piles shall be cutoff a minimum of 1 ft below the design bottom of the pile cap and abandoned at no cost to the Owner. Additional piles required to compensate for an abandoned pile shall be driven as directed by the Geotechnical and Structural Engineers, at no additional cost to the Owner.
3. Prepare all pile types to receive connection to pile cap and/or floor slab.

3.6 SPLICING AND WELDING

- A. A maximum of one splice per pile shall be allowed. Splices shall develop 100 percent of the pile strength in compression, tension and bending.
- B. Pile splices shall be located so as to permit continuous driving through the glacial till and bedrock, and to final end bearing.
- C. All welding shall be performed in accordance with the applicable provisions of the AWS Code. Ultrasonic testing of welds at pile splices shall be performed by an independent testing agency approved by the Owner, at the Contractor's expense. Testing shall be in conformance with ASTM E164. The Contractor shall cooperate with the testing agency to facilitate inspection. Welds which do not conform to applicable specifications shall be repaired at no additional cost to the Owner.

3.7 TOLERANCES AND CRITERIA FOR ACCEPTANCE

- A. Location: Piles shall be driven as close as practicable to the plan location. A maximum lateral deviation from the correct location measured in any direction at cut-off elevation will be 3 in. for all piles. A maximum deviation from design cut-off elevation equal to 1 in. will be permitted.
- B. Plumbness: The pile plumbness, as measured on the projection of the pile above ground, shall not deviate by greater than ten percent from the vertical

alignment. Pulling piles into alignment or position will not be permitted.

- C. Piles that are damaged below cut-off elevation during driving will be rejected. If, upon comparing pile performance during driving with that of other driven piles, and based on the Geotechnical Engineer's knowledge of subsurface conditions, the Geotechnical Engineer determines that a pile has been unacceptably damaged; the Geotechnical Engineer may reject the pile.
- D. Piles indicating sudden or peculiar decrease in penetration resistance during driving will be assumed to be broken or damaged, and will be rejected unless the Geotechnical Engineer's review of available data indicates that sudden decrease in driving resistance is due to natural subsurface conditions and continued acceptable driving behavior is observed.
- E. Piles that are rejected because of damage, mislocation or misalignment, or failure to meet the driving criteria due to causes other than obstructions as defined herein, shall be cut off a minimum of 1 ft below the design bottom of the pile cap and abandoned, and additional piles shall be driven as directed by the Geotechnical Engineer at no additional cost to the Owner.
- I. When otherwise acceptable installed piles exceed the specified tolerances, the Structural Engineer will analytically determine the total loads on individual piles, based on a survey by the Contractor's Surveyor. If the load on any pile exceeds 110 percent of the specified load capacity, corrections shall be made by adding piles, or other procedures, in accordance with a design provided by the Structural Engineer.
- J. The installation of replacement piles and other corrective measures shall in all cases be in accordance with designs provided by the Structural Engineer.
- K. Any increased costs for redesign and for construction caused by rejected piles or piles exceeding tolerances not caused by obstructions shall be the responsibility of the Contractor.
- L. Vibration levels will be monitored as necessary by the Geotechnical Engineer during pile driving.

END OF SECTION