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1.0 PURPOSE

This procedure establishes safety requirements for the installation and extraction of piles during construction and demolition operations. The requirements contained herein apply to piles comprised of hot and cold rolled steel, concrete, wood, and composite materials, and continuous flight augured (CFA) piles.

2.0 SCOPE

The scope of this procedure applies to all works performed under all Government Construction Contracts executed throughout the Kingdom of Saudi Arabia.

3.0 DEFINITIONS

Definitions	Description
Anvil	The bottom portion of a pile hammer that receives the impact of the ram and transmits energy to a pile.
Batter Pile	A pile driven at an inclination to the vertical to provide resistance to horizontal forces.
Bounce	The hoisting of a load, momentarily releasing the brake, catching the load with the hoist line and braking again.
Competent Person	One who can identify existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees, and who has the authority to take prompt corrective measures to eliminate them.
Continuous Flight Augured (CFA) Pile	CFA piles (or auger cast-in-place (ACIP) piles are a deep-foundation element characterized by drilling a hollow-stem auger into the ground to form the pile's diameter. Sand-cement grout or concrete is pumped into the hole as the auger is removed, eliminating the need for temporary casing or slurry. After the auger is removed, reinforcement is installed.
Cushion Block	A pad, most commonly comprised of plywood, placed on top of pre-cast concrete piles to eliminate spalling.
Cushion Pad	A pad of resilient material or hardwood placed between a helmet and drive cap adapter.
Deflector Sheave	Sheave(s) used to change the direction of travel of a crane hoist line.
Drive Cap Adapter	A steel unit designed to connect a specific type of pile to a specific pile hammer, most commonly connected to the pile hammer by steel cables.
Drive Cap Insert	A steel unit that is shaped to fit over the top of various types and shapes of piling, and which positions the pile under the drive hammer and connects it to the drive cap adapter.
Driving Head	A steel accessory placed over a pile to prevent damage from driving. A driving head is suspended beneath a pile hammer by cables; it contains a well or recess on its top for cushion material and for seating an anvil (if used). Its bottom is formed to accept a specific shape of pile, along with its cushion (if used). Its outside incorporates a lug or insert slot for attachment to the lead system. A driving head is also referred to as an anvil block, bonnet, cap, helmet, follow cap, rider cap, or shield.
Fall	A measure of a rigging component's vertical length.
Follower	An extension used between a pile and pile hammer that transmits blows to the pile when the pile head is either below the reach of the pile hammer (below the guides/leads) or under water. A follower is commonly a section of pipe or "H" pile with connections that match both the pile hammer and the pile being driven.

Definitions	Description
Ground Conditions	The condition of the ground as it relates to its adequacy for support of pile driving equipment and stored materials, including the ground's slope, compaction, and firmness.
Guide Rail	That part of the pile hammer leads which forms a pathway for the pile hammer and which consists of parallel members that mate with the side channels of the pile hammer. Guide rails are also referred to as "Lead Rails" or "Hammer Guides."
Hammer, Drop Impact	A pile hammer (also referred to as "Drop" Hammer or "Hair Pin" Hammer). For purposes of this procedure, there are four types of drop impact hammer:
Cable Operated Drop Hammer	A drop impact (pile) hammer consisting of a machine lifted weight which can free fall to drive the pile.
Steam Drop Hammer	A drop impact hammer consisting of a cylinder which acts as the falling weight which is lifted by steam pressure.
Hydraulic Drop Hammer	A drop impact hammer consisting of a segmented ram which is lifted by hydraulic pressure to a pre-set height. The pile hammer is then allowed to fall onto a driving cap. The weight and height of the ram can be varied to suit site conditions.
Diesel Drop Hammer	A drop impact hammer consisting of a cylinder which acts as the falling weight which is operated by compression-ignition because of the weight falling and compressing the contents of the cylinder.
Kicker	The strut between the crane and the pile leads (also referred to as a "Spotter").
Leads	Two parallel members of a wooden or steel frame for guiding the pile hammer and piles in correct alignment. There are three types of leads:
Fixed Leads	Leads which are fixed to a pile rig at its top and bottom.
Swinging Leads	Leads which are supported at the top by a cable attached to a pile rig.
Semi-Fixed or Telescopic Leads	Leads which can translate vertically in relation to a pile rig's boom tip.
Lifting Bail	Rigging apparatus used to attach a crane hoist line to the pile driving equipment.
Micropile (Minipile)	A small diameter, high capacity pile that can be drilled, pushed, or augured into the ground. They are specifically utilized in low head room or restricted areas.
Moonbeam	A Moonbeam is a crescent shaped mechanism that enables piles to be driven at an angle (batter) from side to side.
Pile	A concrete, steel or wood column which is driven or otherwise introduced into the soil, usually to carry a vertical load or to provide lateral support.
Pile Contractor	A contractor whose scope of work on a Project includes the installation and/or extraction of piles.
Pile Gate	A hinged section attached to the pile leads, at the lower end, which serves to keep the pile within the framework of the pile leads.
Pile Hammer	A device which develops and expends the energy used to drive piles, the two main parts of which are the ram and the anvil. Also, referred to as a "Pile Driver Hammer."
Pile Head	The upper end of a pile.
Pile Rig	The crane or other type of equipment used to support the leads and pile driving assembly during a pile driving or extraction operation.
Power Plant	A prime mover consisting of an engine and generator, hydraulic pump or compressor used to provide electricity, hydraulic power, or compressed air to portable construction equipment such as a vibratory pile hammer/ extractor or impact pile hammer/extractor.
Ram	The moving part of a pile hammer, consisting of a piston and a driving head, or driving head only.

Definitions	Description
Sheave	An assembly consisting of a pulley wheel, side plates, shaft, and bearings over which a cable or rope is passed. For purposes of this procedure, there are two types of sheave:
Deflector Sheave	A sheave used to change the direction of travel of a crane's hoist line.
Turn-Around Sheave	A fixed sheave mounted to a pile hammer for increasing the mechanical advantage of a crane's hoisting capacity.
Sheeting Shackle	A specialized rigging assembly used to hoist and set sheet piles.
Spotter	The strut between the crane and the pile leads (also see "Kicker").
Spudding	The driving of a short and stout section of pile-like material into the ground to penetrate or break up a hard ground strata and permit pile driving, common in the driving of timber piles.
Stroke	The length of fall of a ram.
Supporting Material	Blocking, mats, cribbing, marsh buggies or similar supporting materials or devices.
Template	A fabricated guide of almost any shape, used to align piling before driving.
Trip Latch	A block in the leads of a drop impact hammer which causes the release of the pile hammer's weight at a predetermined height or a mechanical device used with a diesel hammer to pick up and release the piston to start the pile hammer. Also, referred to as a "Trip Block" or "Tripping Device."
OSHA	Occupational Safety and Health Administration
HSSE	Health, Safety, Security and Environment
JHA	Job Hazard Analysis
PPE	Personal Protective Equipment
WMS	Work Method Statements
STARRT	Safe Task Analysis and Risk Reduction Talk

4.0 REFERENCES

- OSHA 29CFR 1926 Subpart CC Cranes and Derricks in Construction
- OSHA 29CFR 1910 Subpart G Occupational Health and Environmental Control
- EPM-KSS-PR-000001 Project General Safe Working Requirements Procedure
- EPM-KSS-PR-000003 Project Personal Protective Equipment Procedure
- EPM-KSS-PR-000005 Project Fall Protection Procedure
- EPM-KSS-PR-000006 Project Barricades and Signs Procedure
- EPM-KSS-PR-000008 Project Elevated Work Platform Procedure
- EPM-KSS-PR-000011 Project Portable Ladders Inspection and Control Procedure
- EPM-KSS-PR-000013 Project Work Over or Near Water Procedure
- EPM-KSS-PR-000015 Project Suspended Personnel Platform Procedure
- EPM-KSS-PR-000017 Project Powered Industrial Trucks Procedure
- EPM-KSS-PR-000018 Project Crane and Lifting Operation Procedure
- EPM-KSS-PR-000028 Project Floor and Wall Openings Procedure
- EPM-KSS-PR-000031 Project Lockout/Tagout Procedure
- EPM-KSS-PR-000032 Project Excavation and Trenching Procedure
- EPM-KSH-PR-000010 Project Hearing Conservation Program

5.0 RESPONSIBILITIES

In addition to general responsibilities, the following are specific to Piling and this Procedure.

5.1 Pile Contractor

- Develops a written Safety Plan for the Scope of Work.
- Ensure that all affected personnel review the Safety Plan prior to work start.

- Provides a construction plan outlining the sequencing of piling operations, including at a minimum, work schedule, number and type of rigs, and staging requirements.
- Submits a plan for verifying the existence of underground utilities prior to commencing piling operations. The plan shall contain specific methods of verification (e.g., visual, remote, drawing review, test pit, etc.).
- Provides a geotechnical report and submit to Site Management for review and approval.
- Ensures all personnel engaged in pile driving operations have been properly trained.
- Designates a Competent Person for pile driving operations.
- Verifies work site conditions and readiness for pile driving operations.
- Ensures all equipment in use has been properly inspected in accordance with manufacturer requirements.
- Ensures that all personnel involved in pile driving operations are provided with and are using the required Personal Protective Equipment (PPE).
- Monitors meteorological conditions at the work site for potential weather extremes that could result in work stoppage.
- Submits a Job Hazard Analysis (JHA), or equivalent (Method Statement/Risk Assessment), to Project HSSE for review prior to work start.

5.2 Geotechnical Advisor

- Reviews and approves contractor's geotechnical report.
- Provides guidance and clarification of requirements, to pile contractors, where applicable.
- Reviews Contractors construction plan.

5.3 Project Management

Project/Site Management must ensure that the following requirements are complete before allowing piling operations to proceed:

- Ground preparations necessary to meet the requirements of Sect 5.1 of this procedure.
- Inform the Pile Contractor of the locations of subsurface hazards (such as voids, tanks, utilities) where pile driving equipment will be used and provide the contractor with client-supplied drawings showing the locations of known underground utilities.
    - The locations of such hazards shall be identified in documents such as site plans, as-built drawings, and geotechnical reports.
    - A contingency plan will be developed to protect personnel in the event contaminated soil is encountered in existing facilities. The plan will define PPE requirements, disposal of contaminated soil as well as fire and explosion prevention.
- Verify all required inspections and, where applicable, certifications of all lifting equipment to include cranes and associated rigging used for pile driving operations.
- Review and approve the Contractor's Construction Plan.
- Review and approve the contractor's underground utility verification plan.
- The Project Manager is responsible for ensuring the resources and arrangements are available for the implementation and management of this procedure.

5.4 Project HSE Management

- Reviews and approves contractor's Safety Plan for pile driving operations.
- Verifies all training and medical requirements have been completed for employees involved in pile driving operations.
- Ensures that the appropriate PPE is available and is being used by all personnel located within the area that has been designated for pile driving operations.
- Monitors operations to ensure proper implementation and enforcement of the requirements of the contractor's Safety Plan, and the requirements of this Procedure.

- Ensures that meteorological conditions are monitored during pile driving operations (particularly lightning strikes).

5.5 Employees - Pile Driving Operations

- Reviews Safety Plan for pile driving operations prior to work start.
- Reviews JHA or Method Statement (as applicable) for pile driving operations prior to work start.
- Ensures that they have received all the required training for pile driving work tasks.
- Completes all required medical examinations as specified for personnel involved in pile driving operations.

6.0 RISK ASSESSMENT

An integral aspect of the work planning process is the performance of a proper risk assessment. Risk Assessments must be conducted at the Planning Stage to identify the hazard risks and determine control measures.

The Risk Assessments that shall be conducted at the Planning Stage are as follows:

- Project Risk Assessment.
- Work Method Statements (WMS)
- Job Hazard Analysis (JHA).
- Safe Task Analysis and Risk Reduction Talk (STARRT).

It is imperative that prior to beginning any work activity, a STARRT briefing occurs to discuss the contents of the WMS/JHA which includes mitigations for any other hazards noted by the crew at the jobsite. The discussion shall also include job steps, expected hazards associated with the activity, and the mitigation and protection methods that shall be implemented to prevent incidents.

The Hierarchy of control shall be used to reduce the likelihood of an incident occurring.

- **Elimination** (Remove the Hazard)
- **Substitution/Isolation** (Replacing material, process or hazard with a lower risk one/separate people from the hazard, use suitable guarding, distance, etc.)
- **Engineering Controls** (Redesign or replacement of plant and equipment)
- **Administration Controls** (Procedures, training, signage)
- **PPE -** Personal Protective Equipment

No work is to commence until the above has been implemented and signed by the relevant Supervisor in charge.

7.0 GENERAL REQUIREMENTS

7.1 Planning Requirements

Prior to initiating pile driving or extraction operations, the planning action requirements of this Procedure shall be completed prior to work commencing.

7.1.1 Pile Contractor

The pile contractor shall develop a written site-specific Safety Plan. The site-specific construction plan shall address (at a minimum), the proposed equipment, personnel, sequencing of rigs, daily work schedule, overall work schedule, and contingency plans for unplanned downtime, and unplanned work stoppages. Specifically, the safety plan shall:

- Identify specific steps for the intended operations.

- Provide a list of the potential hazards associated with those operations.
- Establish the procedures to minimize or eliminate those hazards.
- Ensure a plan is in place to address permit requirements, utility right of ways, excavation permits.

The contractor's safety plan shall, as a minimum, address the following key elements:

- The location(s) of utilities (both above and below grade).
- Designated areas for equipment operations and materials storage.
- Assembly and disassembly sequences for pile driving equipment.
- Operation and certification of pile driving equipment.
- Equipment Inspection schedules
- The handling of pile materials and equipment.
- Isolating the area
- Protecting the crews and other personnel form falling in open holes.
- Noise monitoring.

In addition, a geotechnical report shall be developed to identify subsurface conditions and provide geotechnical conclusions and recommendations for design and construction of the Project. This report must be reviewed and approved by Project Management before work continues.

The contractor's Safety Plan shall be reviewed with all employees involved in or exposed to the pile operations. A copy of the safety plan shall be maintained at the Project Site and available for review until the work is complete.

As changes in the operations are made, the Safety Plan shall be changed accordingly. Such changes shall be communicated to all persons involved in or exposed to the operations.

7.1.2 Training and Medical Requirements

The pile contractor shall ensure that its employees have been properly trained in the specific pile driving activities to be conducted. They must also provide verification that applicable personnel have completed the necessary medical testing prior to beginning work. Specifically:

- Written certification or documentation demonstrating that contractor personnel have completed the required training
- In cases where training requirements and/or certifications cannot be provided by the contractor, then Site Management must ensure that the contractor employees understand the hazards of pile driving operations and the associated requirements for hazard mitigation and control, as outlined in this Procedure.
- Appropriate medical examination forms showing that applicable personnel have received the required base-line audiometric testing with annual retesting, as required.

7.2 Site Condition Requirements

Prior to initiating pile driving or extraction operations, the requirements of this Section pertaining to work site conditions must be completed.

- Pile driving equipment shall not be assembled or used unless the ground conditions on which they are moved or placed are firm, graded and, unless the work is being performed in marshes or wetlands, drained, to the extent that the use of supporting materials is adequate and the equipment manufacturer's specifications for adequate support and degree of level are met.
- The pile contractor shall establish a controlled access zone around the installation, driving, hoisting and/or extraction areas to prevent access by persons not directly involved in such operations. The controlled access zone shall be maintained under the supervision of a Competent Person.
- The radius of the work area (minimum distance of the pile being installed) must be barricaded or flagged-off with hearing protection requirements posted to prevent unauthorized personnel from entering. This distance should be established based, in part, on the length of the pile and/or height

of the leads/boom. This distance can be reduced after the pile has been driven a minimum of 3 meters.

- If other contractors' employees, or the public (where applicable), intrude upon the controlled access zone, the pile contractor shall cease operations and warn such persons to move to a safe location. The pile contractor shall inform Project/Site Management of such intrusions. Project/Site Management shall take appropriate and reasonable actions to prevent such intrusions.

7.3 Pile Delivery and Storage Requirements

- Piles or sheet piling stored on the ground shall be adequately supported by blocking.
- Pipe piles shall be stacked in well supported and braced racks or frames, unless other provisions are made to prevent unintended movement.
- Sorting of piles after stacking shall conform to Section 7.4 of this Procedure with respect to employee hoisting, positioning, and signaling.
- The handling and storage of pre-cast concrete piles shall be performed in a manner that prevents damage to the piles:

    - Care shall be taken to place bearers only at lifting positions.
    - Concrete piles shall be lifted only at the points indicated on the plans.
    - Concrete piles shall not be driven until they have attained sufficient compressive strength.

7.4 Materials Handling to Point of Final Use

- The pile contractor shall comply with the manufacturer's specifications and limitations as well as Procedures applicable to the operation of cranes, forklifts, front-end loaders, boom trucks, and other mechanized equipment used to handle piling material. See Section 4.0 References, for a listing of the documents pertaining to the use of the various types of equipment.
- Only rigging of adequate size, configuration, and capacity shall be used to handle piles.
- Piles shall not be sorted with open hooks or sheeting shackles unless they are designed for that purpose.
- Piles shall not be hoisted with open hooks or open sheeting shackles.
- All piles, particularly pre-cast concrete, shall have appropriately designed lifting points.
- Rigging and handling of pile material and equipment (e.g., lifting bail, leads, cables, etc.) shall be in accordance with EPM-KSS-PR-000018 Project Crane and Lifting Operation Procedure as applicable.

7.5 Power Equipment

- Meteorological monitoring should be performed to ensure a safe working environment for power equipment. Continuous monitoring shall be performed if atmospheric hazards are suspected/ forecasted or present.
- Fuel-operated power plants shall not be operated in an enclosed area unless exhaust is adequately ventilated or ducted away from the work areas.
- All steam pressure vessels used for pile installation and extraction operations shall comply with applicable codes for pressure vessels.
- Boilers, air compressors, and hydraulic power units shall be inspected, maintained, and operated in accordance with applicable manufacturers' requirements.
- Additional (auxiliary) equipment, such as boilers, hydraulic power units, or air compressors which are mounted to a crane for use in pile driving operations, shall have a platform designed to provide safe access for operation and maintenance of the unit(s) and to support the weight of the equipment. The additional weight of such equipment shall be a factor in the design and safe operation of the auxiliary equipment and shall not affect the lifting capacity or safe operation of the crane.

7.6 Pressurized Lines and Hoses

- All steam or compressed air line connections, including those to pile hammers, pile ejectors, or jet pipes, shall be securely tethered with an adequate length of alloy steel chain having a working load limit of not less than 1474kg or an alloy steel cable of an equivalent capacity to prevent uncontrolled movement of lines in the event of accidental detachment.
- Chains or wire rope used as line restraints shall not be shortened with knots, bolts, or other makeshift devices.
- Hoses, fittings, and related assemblies shall not be intermixed unless they are deemed compatible by their manufacturers and meet the requirements of this Procedure.
- The working pressure of hoses used shall be greater than or equal to the maximum designed system pressure of the equipment.
- Steam and compressed air line controls shall consist of two shut-off valves. At least one shut-off valve shall be equipped with a quick-acting lever within easy reach of the pile hammer operator.
- Pneumatic systems shall be protected by an air flow reduction valve at the source to prevent uncontrolled movement of the line(s) if a coupling becomes disconnected or damage occurs elsewhere in the hose.

    - The valve shall be sized according to the pile hammer's pressure supply requirement, and shall not be oversized.
    - All such valves shall be inspected for proper operation at least once per shift.

- Hydraulic-powered pile hammer hose lines and fittings shall comply with applicable codes and standards and fit-for-purpose (job-made lines and fittings are prohibited).
- Hydraulic hoses shall be routed to avoid flexing to less than their specified minimum bend radii, twisting, pulling, kinking, crushing, or abrading.
- Hydraulic systems shall not be operated above the maximum or below the minimum temperatures specified by the manufacturer.
- Pressurized systems such as steam, pneumatic, or hydraulic, shall be bled and locked or tagged-out before service is performed on the system(s), and electrical power sources shall be disconnected and locked or tagged-out in accordance with EPM-KSS-PR-000031 Project Lockout/Tagout Procedure.
- All pressure gauges shall read zero before lockout procedures are implemented.
- Electrical systems shall be properly grounded/earthed during operation.

7.7 General Pile Driving Requirements

- All employees involved in pile installation, extraction, and related operations shall wear the required PPE. As a minimum, the following PPE is required for piling operations covered by this Procedure:

    - Hard hat.
    - Eye protection with approved side shields.
    - Gloves appropriate for handing operations.
    - Foot protection.
    - Fall protection on equipment.
    - Hearing protection (Double hearing protection or personal hearing protection, as applicable).

- Hearing Conservation Program requirements, to include audiometric testing and hearing protection (PPE) shall conform to the provisions of EPM-KSH-PR-000010 Project Hearing Conservation Program.
- The manufacturer's recommendations for the assembly and disassembly, inspection, maintenance, and operation of the installation equipment and piling element installation shall be followed.
- If a mobile crane is used with either fixed or swinging leads, the crane and its operation shall comply with EPM-KSS-PR-000018 Project Crane and Lifting Operation Procedure.
- The pile contractor shall comply with the manufacturer's specifications and limitations applicable to the operation of dedicated, self-contained, hydraulic pile driving equipment.
- A blocking device capable of safely supporting the weight of the pile hammer shall be provided for placement in the leads under the pile hammer and used always while employees are working under the pile hammer.

- Before any type of pile is placed in position for driving, the pile head must be cut square to the driving head and free of bark, splintered wood, frozen soils, spall, steel fragments, or other debris. This requirement also pertains to pile spudding, if applicable.
- Where the boom, counterweight, or other structural part of a crane has been modified to accept equipment related to pile driving (e.g. leads, pile hammers, power supply, etc.), the contractor shall demonstrate that the modification(s) will not affect the safe operation of the crane.
- No person shall stand under the kicker or directly under, in front of, or within at least 3.6 meters of the pile hammer or pile when a pile is being driven.
- A designated signal person shall be positioned in full view of the equipment operator before any pile driving equipment is relocated at the work site. Standard crane signals shall be used by all employees. The operator shall accept signals only from the designated signal person except for an emergency stop signal, which may be given by any employee.
- When driving piles in any batter configuration, the equipment (crane, piling leads, kicker, and pile hammer) shall be suitable for the intended batter.
- During pile hoisting, tag lines or similar devices shall be used where necessary to control rotation of the load. Safety lugs shall be welded to steel pipe piles to prevent the pile line from slipping off the pile during hoisting. Whenever possible, the top of the pile shall be guided under the pile hammer from the ground to eliminate the need for climbing the leads to set the pile. Only employees who are trained in the specific hazards of the operation shall be in the work area where these operations are taking place. All site employees shall be alerted to and stay clear of the pile hoisting operation.
- If an employee is required to climb the driving leads, the operator of the equipment will apply all brakes and necessary safety switches to ensure no uncontrolled motion of the equipment.
- If a crane is used for pile driving operations, the operator shall correctly pay-off or lower the hoist lines attached to the pile and pile hammer as the pile is driven.
- The driving hammer shall be inspected at least once every shift. If hard driving is encountered, more frequent inspection is required. These inspections shall include, but may not be limited to, the following elements:

    - All bolts.
    - Cable clamps.
    - Cables.
    - Cushion blocks.
    - Cushion pads.
    - Fuel lines.
    - Followers (where applicable).
    - Rail bolts.
    - Guide rails.
    - Cocking and trip mechanisms.
    - Fuel pumps.
    - Injectors.
    - Drive head retaining pins.
    - Drive cap adapter and inserts.

- Whenever diesel pile hammers are being fueled, the oil reservoir shall be checked and re-filled as necessary. All grease fittings (if so equipped) on pile hammers shall be greased at least once per shift or as recommended by the pile hammer manufacturer.
- Shackles shall be secured against unintended opening by steel wire or equivalent. Field-made lifting devices are prohibited.
- All driving operations shall be momentarily suspended if the load line from a pile being driven is or becomes detached.
- Stop blocks shall be provided for the leads to prevent the pile hammer from being raised against the head block
- All employees shall be kept clear when piling is being hoisted into the leads.
- When steel tube piles are being blown out, employees shall be kept well beyond the range of falling materials.
- When driving, or jacking piles in pits or pile caps 1.2 meters or more in depth, the excavation shall be inspected by a Competent Person for cave-in and atmospheric hazards. The need for protection

measures (e.g., shoring, benching, etc.) shall also be assessed at this time. Access to and from the excavation shall be by ladders or ramps in accordance with EPM-KSS-PR-000032 Project Excavation and Trenching Procedure.

- Cushion blocks constructed of plywood or other combustible materials used when driving pre-cast concrete piles will typically ignite due to friction. An appropriate quantity of properly rated fire extinguishing equipment shall be located nearby the driving operation. Cushion blocks for pre-cast concrete piling shall be changed at least once for every pile driven.
- Hoisting and driving of piling shall be performed in a manner that positively prevents accidental detachment of the pile from the hoisting equipment's lifting hook. A shackle may be used in lieu of a hook.
- Taglines shall be used for controlling unguided piles and free hanging pile hammers.
- Where a drop impact hammer is used for driving piles other than sheet piling, a driving head or bonnet shall be provided to bell the head of the pile and hold it true in the leads.
- Personnel shall verify that all indications of burning have been eliminated before any cushion block that had previously been burning is disposed of in any bib or refuse container.
- Pile hammers shall be lowered to the bottom of the leads while the pile driver is being moved.
- Power units shall be operated at full recommended operating speed during the driving cycle.
- Cable stays used for aligning sheet pile(s) during driving operations shall be removed from the sheet pile(s) before they are to be driven.
- When the leads must be inclined in the driving of batter piles, provisions shall be made to stabilize the leads, such as a moonbeam arrangement and/or spotter.
- Guy wires, outriggers, thrust-outs, or counter-balances shall be provided as necessary to maintain stability of pile driver rigs.
- When pile hammers are stored, they shall be secured against accidental displacement.
- When it is necessary to cut off the tops of driven piles, pile driving operations shall be suspended at least twice the length of the longest pile from the driver, except where the cutting operations are located.
- Pieces shall be mechanically lifted when they are cut off.

7.8 Specific Pile Hammer Requirements

The following requirements pertain to the various types of pile hammer mechanisms that are commonly used for piling operations.

7.8.1 Vibratory Pile Hammers

- The pile hammer, clamp, power unit and supply hoses shall be inspected in accordance with their manufacturer's recommendations. Associated equipment, such as the couplings, support and lifting equipment, rigging, and retaining bolts shall be inspected before each shift and periodically during use.
- When driving with a crane-suspended vibratory pile hammer, the person operating the remote on/off clamp switch shall be in direct visual contact with the signal person.
- A vibratory pile hammer shall not be unclamped from a pile when there is any line pull on the suspension or when the pile hammer is still vibrating.
- The power unit's engine and hydraulics shall reach recommended operating temperatures before the hammer is operated.
- Rigging attached to the lifting pin of the pile hammer shall can support the weight of the pile hammer and piling to be driven or extracted. These weights shall not exceed the manufacturer's specifications.
- The pile shall be firmly gripped by the exciter's jaws when clamping. The correct clamp shall be used for the shape of the member being driven or extracted.
- The exciter (vibratory pile hammer) shall not be unclamped from the pile when there is any line pull on the suspension or when the pile hammer is still vibrating.
- Verification of the hammer operating frequency shall be made, as appropriate.

7.8.2 Steam Pile Hammers

- The pile hammer, clamp, power unit and supply hoses shall be inspected in accordance with their manufacturer's recommendations.
- Associated equipment, such as the boiler, support and lifting equipment, rigging, couplings and retaining bolts shall be inspected before each shift and periodically during use.
- All steam supply piping and hoses shall be properly sized to prevent undue flow restrictions.
- Only driving heads of the correct size and shape for the pile to be driven shall be used.
- Driving heads shall be kept aligned with the pile and pile hammer as a pile is driven.
- Employees shall remain clear of the exhaust, valve mechanism and slide bar, columns, supporting rig, ram, pile cap, and ram point when the pile hammer is in operation.

7.8.3 Hydraulic Pile Hammers

- The pile hammer, clamp, power unit and supply hoses shall be inspected in accordance with their manufacturer's recommendations.
- Associated equipment, such as the boiler, support and lifting equipment, rigging, couplings and retaining bolts shall be inspected before each shift and periodically during use.
- All hydraulic supply piping and hoses shall be properly sized to prevent undue flow restrictions.
- Only driving heads of the correct size and shape for the pile to be driven shall be used.
- Driving heads shall be kept aligned with the pile and pile hammer as a pile is driven.
- Employees shall remain clear of the exhaust, valve mechanism and slide bar, columns, supporting rig, ram, pile cap, and ram point when the pile hammer is in operation.

7.8.4 Pneumatic Pile Hammers

- The pile hammer, clamp, power unit and supply hoses shall be inspected in accordance with their manufacturer's recommendations.
- Associated equipment, such as the boiler, support and lifting equipment, rigging, couplings and retaining bolts shall be inspected before each shift and periodically during use.
- All pneumatic supply piping and hoses shall be properly sized to prevent undue flow restrictions.
- Only driving heads of the correct size and shape for the pile to be driven shall be used.
- Driving heads shall be kept aligned with the pile and pile hammer as a pile is driven.
- Employees shall remain clear of the exhaust, valve mechanism and slide bar, columns, supporting rig, ram, pile cap, and ram point when the pile hammer is in operation.

7.8.5 Diesel Pile Hammers

- The pile hammer, clamp, power unit and supply hoses shall be inspected in accordance with their manufacturer's recommendations.
- Associated equipment, such as the boiler, support and lifting equipment, rigging, couplings and retaining bolts shall be inspected before each shift and periodically during use.
- The pile hammer and leads shall be of a compatible size, shape and capacity.
- The pile driving crew members shall be familiar with how the specific diesel-powered pile hammer is started and stopped during normal and emergency conditions.
- Cold starting of a diesel pile hammer shall be in accordance with the manufacturer's recommendations. Extreme caution shall be observed in preventing flammable material explosion(s) and forceful ejection(s) of exhaust.
- Diesel-powered pile hammers shall not be lubricated, serviced or repaired while in operation.
- All crew members shall be trained in and demonstrate familiarity with:
    - The safe operation of the hammer's diesel trip mechanism (latch or block).
    - The fire, explosion and exhaust-related hazards associated with cold starts.

7.8.6 Drop Impact Hammers (Hair Pin)

- Only driving heads of the correct size and shape for the pile to be driven shall be used.
- Driving heads shall be kept aligned with the pile and pile hammer as a pile is driven.

7.9 Pile Leads

- Leads shall be assembled in accordance with their manufacturer's specifications using only the approved fasteners and required torque values.
- Bent or otherwise deformed or damaged lead sections should not be used.
- All repairs to leads and lead components shall be made in accordance with their manufacturer's specifications.
- Shop made piling leads and attachment connections shall be designed by a registered Professional Engineer who has a demonstrated familiarity with such equipment.
- Stop blocks shall be provided for the leads to prevent the pile hammer from being raised against the head block.
- A blocking device, capable of safely supporting the weight of the pile hammer, shall be provided for placement in the leads under the pile hammer whenever an employee is working under the pile hammer.
- Guards shall be provided across the top of the head block to prevent the cable from jumping out of the sheaves.
- When the leads must be inclined in the driving of batter piles, provisions shall be made to stabilize the leads.
- Pile gates shall be of a size sufficient to secure piling at the bottom of the leads during driving operations.
- At no time is an employee to open the gates while a pile hammer is driving a pile.

7.9.1 Access to Pile Leads

- Pile leads shall be provided with a ladder or horizontal bracing that is uniformly spaced at intervals no greater than 46cm and which prevents employees from contacting the pile hammer. Such assemblies shall be equipped with adequate anchorages and or retractable lifelines for personal fall protection equipment in accordance with the applicable requirements of EPM-KSS-PR-000005 Project Fall Protection Procedure. If the leads are provided with loft platform(s), such platform(s) shall be protected by standard guardrails, as per EPM-KSS-PR-000006 Project Barricades and Signs Procedure and EPM-KSS-PR-000028 Project Floor and Wall Openings Procedure
- When used, platforms attached to pile driving leads shall be of sufficient size to enable employees to avoid contact with the pile hammer. Platforms shall be equipped with a standard guardrail on all open sides, except between the platform edge and the pile hammer leads. Guardrails shall meet the applicable requirements of EPM-KSS-PR-000006 Project Barricades and Signs Procedure and EPM-KSS-PR-000028 Project Floor and Wall Openings Procedure.
- Toe boards shall be installed on all sides of the platform.
- No employee shall remain aloft in or on the leads during the driving or extraction of piles unless there is no other feasible means to perform the task. Written approval from the Project HSE Representative and the Site Manager (or designee) must be obtained prior to allowing personnel to remain aloft in or on leads during such operations.

7.10 Sheet Pile Access

- If an employee is required to take a position on sheet piling, the employee shall use a ladder as per EPM-KSS-PR-000011 Project Portable Ladders, Inspection and Control Procedure aerial lift per EPM-KSS-PR-000008 Project Elevated Work Platform Procedure, or crane-suspended work platform per EPM-KSS-PR-000015 Project Suspended Personnel Platform Procedure.
- Employee(s) shall not ride the pile hammer, crane load block, or overhaul ball.
- Stirrups shall be provided for use by employees who must take a position on sheet piles. If an employee uses stirrups on sheet piling, the sheet piling shall be secured from movement so it does not run when the next sheet is threaded into the lock. A suitable anchorage for personal fall protection shall be provided, as per EPM-KSS-PR-000005 Project Fall Protection Procedure.

7.11 Pile Templates

- Walkways on templates shall be kept clear of tripping hazards.
- Each employee on a walking/ working surface (horizontal and vertical surface) with an unprotected side or edge which is 1.8 meters or more above any part of a temporary or permanent structure, template, or cofferdam shall be protected from falling to lower levels by standard guardrails, nets, or personal fall protection equipment in accordance with EPM-KSS-PR-000005 Project Fall Protection Procedure, EPM-KSS-PR-000006 Project Barricades and Signs Procedure, EPM-KSS-PR-000028 Project Floor and Wall Openings Procedure as applicable.
- A ladder or equivalent safe access shall be provided to templates. When a break in elevation of 48cm or more exists between personal points of access, a ladder or equivalent safe access shall be provided between such elevations.

7.12 Continuous Flight Augured (CFA) Piles

CFA piles are grouped based on the type of equipment used to install them. CFA piles generally are available in 30.5 cm - to 91.5 cm diameters and typically extend to depths of 18.3 to 21.3 meters. In some cases, CFA piles have been installed to depths of more than 30.5 meters. Drilled displacement piles are also commonly used.

7.12.1 CFA Piling – General Requirements

- A full risk assessment or job hazard analysis shall be made for each site prior to commencement of work.
- The piling platform must be designed and constructed for the safe operation and maneuvering of the piling rig.
- High pressure concrete pipelines are to be inspected prior to each shift and throughout the operation for wear and defects.
- A designated Rigger must control all rig movements.
- Projecting pile reinforcement materials, such as rebar ends or threaded metal dowels, are to be fitted with protective caps to prevent the hazard of impalement.
- A plan will be developed to ensure adequate handrails are placed on a minimum of three sides of the opening when auguring to prevent personnel from falling in the hole. Unattended open holes will be covered with a secure, marked cover in accordance with EPM-KSS-PR-000028 Project Floor and Wall Openings Procedure.

7.12.2 CFA Piling – Guarding

- The guard on the rig must be kept closed whenever the auger is turning, except as noted below. Should manual intervention be required, then the auger must be stopped.
- On some rigs, a mechanical cleaner may also be used as a guide. If it is to provide guarding, then it would either need to be fixed or have limited movement such as to maintain the required dimensions of guarding.
- To remove soil emanating from the pile during drilling while constructing the pile, the bottom of the guard shall be no more than 500 mm above ground level; or 750 mm above ground level if the spoil is removed by an excavator. No one shall be permitted near the machine, other than the operator in the cab of the rig.
- The top of the guard shall be at such a height above ground level as to preclude personnel coming into contact with the auger in normal usage. This height will be dependent on the shape of the guard but typically the level of the top should be 2.0 meters above ground level.
- It may be necessary to open the guard towards the end of the boring cycle to facilitate the lowering of the drill head to ground level. If such an event is necessary, then the gate must be opened remotely and no personnel shall be around the open gate while the auger is turning. Alternative guarding arrangements will also need to be made if any personnel are, or can be, within such proximity of the auger as to make contact. The guard shall be closed as soon as the rotary table is above the level of the gate during the extraction or concreting cycle.
- Many rigs have fixed access ladders on the mast, which could enable personnel to come into close proximity of an unguarded auger. The auger must not be rotated when personnel are using such

access. It is recommended that the bottom of such ladders is removed while the auger operation is in progress.
- No one should be working in the specific vicinity of the rig without the knowledge and permission of the piling crew. Suitable visible signage shall be placed on the outside of the rig to indicate these access control restrictions.

7.12.3 CFA Piling – Cleaning

All CFA augers must be cleaned to prevent spoil being raised to such a height above ground level as to cause injury in the event the spoil becomes dislodged. Given the guarding requirements specified in the Section above, it can be anticipated that cleaning will take place between 2 and 4 meters above ground level.

The exact level or degree of cleaning must be determined by the Piling Contractor since it is not practical to remove all material. The primary reason for the removal of spoil is to prevent injury and it must therefore be the responsibility of the Contractor to decide what this appropriate level of cleaning shall be on a case-by-case basis.

- A mechanical auger cleaner is to be used to prevent the hazard of falling materials.
- Should any manual cleaning be required for any reason, then the auger must not be rotated while this operation is being performed.
- When a rotary bore pile rig is to be cleaned, the loaded auger shall be carefully slewed off the pile position to the discharge point in a controlled manner.
- When the auger is being spun off, it shall be as close to the ground (or spoil heap) as possible to minimize the spread of spoil.
- The auger spin speed shall be only sufficient to empty the tool to minimize the spread of spoil.
- If the auger cleaning operation is to occur in close proximity to untrained or unaware personnel (e.g., adjacent site boundary or other operations), then suitable barriers will to be erected and precautions taken to contain the spoil and protect any personnel from debris.

7.13 Micropiles

Micropiles are small diameter piles that can be installed in almost any type of ground where piles are required, with design loads as small as three tons and as large as 500+ tons. Also, known as Minipile, pin piles, needle piles or root piles, Micropiles offer a viable alternative to conventional piling techniques, particularly in restricted access or low headroom situations.

Most Micropiles are between 10 cm and 25 cm in diameter, and 15 to 30 meters in length. Micropiles are installed primarily by two methods:

- Drilling and grouting
- Displacement

The safety requirements and precautions for driven piles shall apply also to Micropiles. Additionally, because Minipiles are generally installed in restricted and low head room areas, ventilation and lighting must also be assessed.

- The contractor shall include appropriate ventilation and lighting in the project specific safety plan, including signage for egress in case of emergencies.

7.14 Pile Extraction

- At no time, shall the operator of the crane cause the load to bounce.
- When piles are extracted with a vibratory pile hammer suspended from a crane:
    - The crane shall have a lifting capacity of at least five times the weight of the pile hammer and pile.

  - The rated capacity of the vibratory pile hammer's suspension shall not be exceeded.
  - The manufacturer's recommendations for extracting piling shall be observed at all times.

- When piles are extracted by drop impact:

  - The connection between the pile hammer and the piling shall be sound and inspected often during the extraction process.
  - The crane shall have a lifting capacity of at least five times the weight of the pile hammer and pile.
  - The rated capacity of the drop impact hammer's suspension shall not be exceeded.
  - The manufacturer's recommendations for extracting piling shall be observed at all times.

7.15 Pile Installation Report

Following the installation of all foundation piling, the contractor shall submit a Pile Installation Report that documents the installation of all piles, including but not limited to:

- Driving logs.
- Load test results.
- As-built locations.
- Deviations from the Design Drawings and/or Specifications.

8.0 ATTACHMENTS

1. EPM-KSS-TP-000036 - Project HSSE Pile Driving Operations Checklist

Attachment 1 - EPM-KSS-TP-000036 - Project HSSE Pile Driving Checklist

ATTENTION: Check either "YES," "NO," or "N/A." If corrective action is required, answer "NO." For every "NO" answer, provide a brief description of the issue in the "COMMENTS" column. Add the finding / issue to the ES&H Tracking Register.

No.	ES&H ASSESSMENT – Pile Driving Ops.	ANSWER			COMMENTS
		YES	NO	N/A	
	Subcategory 1: General Requirements				
1.	Does the contractor's ES&H Plan include a risk assessment, SWMS, and JHA of the work to be performed?				
2.	Has the pile contractor developed the required geotechnical report to identify subsurface conditions and provide geotechnical conclusions and recommendations for design and construction of the piling operation?				
3.	Has subcontractor management ensured that all ground preparations necessary to meet the requirements of the Pile Driving Operation have been completed to include informing the Pile Contractor of the locations of subsurface hazards (voids, tanks, utilities) where pile driving equipment will be used?				
4.	Does the pile contractor provide verification that applicable personnel have completed the necessary medical testing prior to beginning work on the contract?				
	Subcategory 2: Site Conditions				
1.	Are ground conditions where pile driving equipment is to be assembled, moved, or used acceptable (e.g., firm, graded, level, drained, etc.)?				
2.	Is the radius of the work area (minimum distance of the pile being installed) barricaded or flagged-off with hearing protection requirements posted to prevent unauthorized personnel from entering?				
3.	When other contractors' employees, or the general public (where applicable), intrude upon the controlled access zone, does the Pile Contractor cease operations and warn such persons to move to a safe location?				