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HYUNDAI ENGINEERING & CONSTRUCTION

AMIRAL PROJECT

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Contract No : 6601000283(IK)

Excavations Safety Procedure

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TABLE OF CONTENTS

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1 PURPOSE

This procedure has been developed to define the actions required to safely control various excavation activities on AMIRAL Program Pkg#4 Projects thus providing safe conditions for all persons working in excavations and underground service and to protect other persons who could be affected by such activities.

2 SCOPE

To be used by the CONTRACTOR Project Management Team, Supervisors and Subcontractors personnel who supervise and control excavation works and construction activities in areas of overhead and underground services.

This procedure and guidance will also provide assistance in the development of a suitable and sufficient risk assessment to determine the appropriate Health and Safety measures to be incorporated into a Safe System of Work on which all persons involved must be instructed, trained and supervised in.

3 DEFINITIONS

The following definition and abbreviation shall be applied for the Project:

Benching	A method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal steps, with a vertical rise between steps
Cave-ins/Soil Collapse	a natural event cause by sudden falling down of soil
Excavation	any manmade cavity, trench, or depression in earth's surface by digging, including its sides, walls or surface formed by earth removal and producing unsupported earth conditions
Trench	is defined as a narrow underground excavation that is deeper than it is wide
Slit Trenching	Slit Trenches are generally long narrow trenches. Excavations of Slit Trenches usually combine hand excavation methods and excavation using a small mechanical excavator equipped with a toothless bucket.
Underground Services	all authorized services placed in the ground and controlled by a recognized authority. It does not include underground structure such as railway tunnels etc.
Overhead power lines	An overhead power line is a structure used in electric power transmission and distribution to transmit electrical energy along large distances. It consists of one or more conductors (commonly multiples of three) supported by towers or poles. Since most of the insulation is provided by air, overhead power lines are generally the lowest-cost method of power transmission for large quantities of electric energy
Protective system	Methods used to protect workers from cave-ins, from materials that could fall or roll into the excavation onto the workers or from collapse of adjacent structures. Protective systems include supports, sloping and benching, shields means to protect workers
Shoring	Shoring is the process of temporarily supporting a building, vessel, structure, or trench with shores (props) when in danger of collapse or during repairs or alterations. Shoring comes from shore, a timber or metal prop. Shoring may be vertical, angled, or horizontal.

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Hydraulic Shoring	A pre-engineered support system of aluminum hydraulic cylinders (cross-braces) used with vertical rods (uprights) or horizontal rods designed specifically to support side walls of an excavation to prevent cave-in.
Sloping	a method of protecting employees from cave ins by excavating to form sides of an excavation that are inclined away from the excavations so as to prevent cave ins. In practice, it may be difficult to accurately determine these sloping angles. Most of the time, the depth of the trench is known or can easily be determined. Based on the vertical depth, the amount of cutback on each side of the trench can be calculated. A formula to calculate these cutback distances will be included with each slope diagram. (NOTE: Remember, the beginning of the cutback distance begins at the toe of the slope, not the center of the trench. Accordingly, the cutback distance will be the same regardless of how wide the trench is at the bottom.
Service Connections	means pipes or cables between distribution mains and individual premises.

4 ROLES AND RESPONSIBILITIES

4.1 Project Manager

Has overall responsibility on the proper implementation of this procedure.

4.2 Discipline Manager (Civil/Architecture)

The discipline manager in charge of the work shall carry out the following activities: Reporting directly to Project Manager/Construction Manager

- Prior to commencing any excavations, complete a survey of the areas to be excavated in order to identify and establish the presence of any temporary or permanent underground utilities and services.
- Establish ground conditions, e.g. the type of ground involved, clay, sand etc. and compaction qualities and water table.
- Identify the need for any permits that are required in the area and arrange for them.
- Brief the Subcontractor carrying out the work of any adjacent operations that may impact on the work, the presence of overhead and underground utilities.
- Ensure that site plan/site layout showing newly installed underground services is updated.

4.3 HSE Manager / Supervisor

- To ensure that all persons involved in the excavation work shall be competent and suitably trained in HSE matters for the operations to be performed.
- Guide project management team in hazard assessment for proper manage and mitigation of excavation work to meet all safety requirements.
- Perform HSE inspection for the excavation work activities on the regular basis, and a written record of findings form daily inspection/audit will be maintained by the inspection/audit corrective action tracking register.

4.4 Supervisor/Foreman

Supervisors shall be responsible for the following:

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- Pre-start briefing for personnel doing the work on the safe working practices required and supporting JSA and Method Statement if applicable;
- Ensuring the implementation of controls as per the relevant Permit To Work;
- Ensuring that suitable and well maintained equipment with all needed documentation is used;
- Providing adequate marking, signs, barriers and supports;
- Programming and scheduling the work to ensure that any excavation maintains access/egress by alternative route;
- Notify the Civil/Architecture Manager of any unmarked utilities found.

4.5 Subcontractors

Shall be responsible for the following:

- Pre start briefing personnel doing the work on the safe working practices required and supporting JSA and Method Statement if applicable
- Application of any work permits. (See the SA-AMI-000-HDAI-710007_WORK PERMIT SYSTEM).
- Provision of equipment that is suitable of carrying out the work safely has been maintained and is certified for use on the project.
- Provision of adequate barriers, flashing lights and signs for the work.
- Provision of adequate shoring and or sloping on the trench during excavation.
- Scheduling the work to ensure that any excavation maintains access/egress by alternative routes.
- Notify the Civil/Architecture Manager of any unmarked utilities found.

5 EXCAVATION SAFETY GUIDELINES

5.1 General

- No ground can be considered totally stable.
- No soil, whatever its nature, can be relied upon to support its own weight for any length of time, let alone any additional loads imposed on it by plant and materials.
- The ground may be inherently weak, laminated or have previously been disturbed.
- Water can create instability in excavation, which can occur through:
  - The effects of rainwater.
  - Changes in groundwater conditions.
  - Erosion by water.
  - Frost action.
  - Drying out of soil.
- All excavations must be made safe by:
  - Sloping the sides to a safe angle of repose, or
  - Installing structural support, e.g. trench sheets, struts, sheet piling, proprietary systems or the use of drag boxes.
- Excavations less than 1.2m deep may not require support if the ground is firm, provided that proper safety procedures exist and are always carried out and monitored.
- All excavations deeper than 1.2m must be considered as confined space and have their sides adequately supported or be battered back to a safe slope.
- One cubic meter of earth weights approximately 1.3tonnes, even if this does not kill a person or persons it is capable of inflicting very serious and may lead to disabling injuries.

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- For excavations greater than 6 m (20 ft) deep, regardless of soil type, an excavation plan (e.g., shoring design calculations and drawings) that meets the requirements of this chapter shall be developed by a degreed civil/structural engineer and reviewed by the SA Consulting Services Department (CSD).
- For excavations greater than 2.4 m (8 ft) deep in Type B or C soil, an excavation plan (e.g., shoring design calculations and drawings) that meets the requirements of this chapter shall be developed by a degreed civil/structural engineer. Striking live underground cables during excavation is also a common danger, resulting in burns to hands, face and body due to arcing electrical currents and the resulting fire.
- Damage to water mains in proximity of excavations can result in the excavation flooding and collapsing.
- Breaking of gas mains or high pressure fuel lines constitutes the danger of explosion and the possibility of persons being asphyxiated by fumes.

5.2 Preparation (Pre Start-up Check)

Before any excavation work is carried out the following procedures and actions will be taken. In addition, design drawings, inspection results, and other licenses required for such procedures should be provided by relevant departments in the site, and joint work should also be carried out when necessary.

- For grassroots projects, the contractor shall develop and implement its own work permit procedures until such time as the AMIRAL work permit system goes into effect. These work permit procedures shall incorporate the excavation safety provisions and checklists.
- A properly completed Confined Space Entry Permit shall be obtained to enter excavations equal to or greater than 1.2 m (4 ft) deep.
- If an excavation plan is required and shoring is used, the plan shall:
  - Describe the materials and shoring system to be used.
  - Indicate whether or not any shoring components will remain after filling or backfilling.
  - Provide plans, sketches and/or details along with calculations.
  - Indicate the sequence and method of shoring installation and removal.
- An excavation safety checklist shall be used to document these initial/daily inspections for a sample excavation inspection checklist hat shall be completed and signed each day by the excavation competent person). If there is an unsafe condition, workers shall not be allowed to enter the excavation.
- A documented inspection shall be performed by an excavation competent person before workers are allowed to initially enter an excavation or after a change in site conditions (e.g., rain storm, groundwater infiltration, sidewall deterioration, adjacent ground fissuring).
- For excavations greater than 2.4 m (8 ft) deep, with the Type B or C soil, an excavation plan (e.g., shoring design calculations and drawings) that meets the requirements of CSM shall be developed by a degreed civil/structural engineer and a documented inspection by the excavation competent person shall be performed each morning before workers shall be allowed to enter the excavation.
- Excavations greater than 6 m (20 ft) deep, regardless of soil type, an excavation plan (e.g., shoring design calculations and drawings) that meets the requirements of CSM reviewed by AMIRAL Consulting Services Department (CSD).
- Drawing of underground installations to be checked e.g. pipeline, cables etc. Location of such facilities to be identified using addressable underground locators.
- Marking of identified underground services and method of excavation, e.g. hand digging requirements will be established for exposing existing utilities.

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- Identifying configuration protective system e.g. timber shoring, hydraulic or pneumatic system, sloping, benching, shielding with COMPANY approval (If required).
- In the event of underground utilities or services are present a supporting excavation certification may be issued for the excavation including all applicable drawings.

5.3 Overhead Power Lines

5.3.1 Operations of cranes and Excavators adjacent to overhead power lines

Operations adjacent to overhead power lines are prohibited unless at least one of the following conditions is satisfied:

- Power has been shut off and positive means undertaken to prevent the lines from becoming re-energized.
- Where power has been shut off and to prevent the lines from becoming re-energized the work should proceed under a permit to work system until it is completed and all persons cleared from the area.
- The local electricity authorities have insulated lines.
- Equipment or any part of it does not have the capability of coming within the minimum clearance from energized overhead power lines specified in the section 5.3.4.
- Barriers erected parallel to the overhead power lines at no less distance than those specified in section 5.3.4, to prevent the possibility of mobile cranes etc. encroaching on the minimum distance. Barriers should be supplemented with high visibility colored tape to form an additional warning (Please refer to [Attachment 1] Illustrations).

5.3.2 Passing of Cranes and Excavators Under the Overhead Power Lines:

The passing of plant underneath overhead power lines is prohibited unless condition of section 5.3.1 has been satisfied. If condition in Section 5.3.1 cannot be implemented the following precaution must be taken:

- The passageway where the plan has to pass under the power line should be limited to one opening as narrow as possible and no more than ten (10) meters wide.
- The route to the passageway must be clearly defined with the use of protective barriers and a goal post erected across the width of the passageway.
- The goal post should be of rigid construction and constructed from non-conducting material (timber) and clearly highlighted for ease of identification.
- Warning notices should be provided and installed at either side of the passageway, informing plant operators of the hazards and providing the height of the cross bar clearance, to make sure that drivers of plant (cranes) lower the jib before reaching the goal post and passing underneath the overhead power line.
- An example of barriers and goalposts are depicted in [Attachment 4] Illustrations.

5.3.3 Working Beneath The Overhead Power Lines

All practicable steps i.e. change of working methods or even re-routing of excavations must be considered as an alternative to working directly beneath overhead power lines.

If it remains essential to carry out work directly beneath the overhead power lines and they cannot be diverted or the power shut off, it is imperative that additional precautions to those listed above in Sections 5.3.1 and 5.3.2 are implemented, these include:

- Seek advice from the Local Electrical Authority and COMPANY for additional precautions to be taken.

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- Plant equipment or tools that could possibly encroach beyond the safe clearance levels must not be taken under the overhead power lines.
- Cranes, excavator's etc. must be modified by installation of physical restraints to prevent them encroaching beyond the safe clearance levels.
- A responsible person appointed to ensure observance of the safe working practices as agreed for working beneath the overhead power lines.

5.3.4 Minimum Clearance Distances Of heavy Equipments like Crane and Excavators from Energized Overhead Power Lines

Nominal System Voltage	Minimum Rated Clearance
0 – 50kV	3.0 Meters
51 – 200kV	4.5 Meters
201 – 300kV	6.0 Meters
301 – 500kV	7.5 Meters
501 – 750kV	10.5 Meters
751 – 1000kV	13.5 Meters

5.4 Horizontal Directional Drilling

- Any existing buried services shall be uncovered and a topography survey of the location performed by the contractor.
- A plan shall be submitted by the contractor showing the required clearance from the proposed bore.
- As the pilot bore commences, the operator shall ensure there is an adequate supply of mud (Bentonite) jetting from the drill head and the operator shall make any required directional adjustments as drilling progresses.
- After the reamer has followed the rods to the machine end and the bore has reached the required diameter, the product pipe shall be carefully pulled through the bore to the required tie-in point.
- Barricades and warning signs shall be erected to keep unauthorized personnel away from the heavy equipment and from the cable hauling the pipe.
- Flagmen shall be present but at a safe distance from the pipe hauling cable when it is under stress.

5.5 Underground Services

- Underground utilities and installations shall be located by reference to drawings, discussion with the relevant organizations and by use of cable/pipe locators.
- Before excavation activities begin, the APO (e.g., engineering/technical) shall confirm and mark (e.g., by flags or chalk) the location of any known or suspected underground pipes, cables, vessels structures, etc., that are in the area of the proposed excavation.
- Mechanical excavators shall not be used within 3 m (10 ft) of underground utilities or installations. Pneumatic breakers shall only be used where necessary to break concrete or other hard materials.
- Existing underground piping, manholes, electrical cables, duct banks, sidewalks, etc., that could be undermined by an excavation shall be properly braced or shored.

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- Any underground cable that is exposed during excavation work shall be assumed to be energized and not to be repositioned or moved until it has been verified to be de-energized by an authorized/certified electrician using an approved potential tester.
- Exposed cables in open excavations shall be properly supported and the area barricaded.
- Any damage to cables during excavation/work activities shall be immediately reported to the SAPO.

5.5.1 Plan of Underground Services

- Requests should be made to the local utility suppliers, COMPANY on the availability of drawings featuring approximate position of underground services.
- It may be possible, if arranged well in advance, that project work be altered to avoid existing underground services to be diverted away from the excavation area.
- Site plans must be updated to show newly installed underground services for future activities in those areas.
- All drawings referring to positions of underground services must be distributed to the Subcontractors involved.

5.5.2 Safe Digging Practices

- A documented inspection shall be performed by an excavation competent person before workers are allowed to initially enter an excavation or after a change in site conditions (e.g., rain storm, groundwater infiltration, sidewall deterioration, adjacent ground fissuring).
- All holes to be carefully dug by the use of hand tools to expose the position of the buried services.
- Digging to take place alongside the underground service and not directly on top of it.
- The use of hand-held power tools and mechanical excavators is a major cause of accidents and must be avoided until the services have been clearly located and identified.
- A safe means of access and egress shall be provided and maintained.

5.6 Protection Against Sidewall Collapse/Cave-ins

5.6.1 Protective Systems

- Suitable shoring shall be installed, or the sides benched or sloped back to a safe angle, for all excavations 1.2 m (4 ft) deep or greater, or for soil piles over 1.5 m (5 ft) high.
- The determination of slope angle, benches or choice and design of shoring shall be based on an evaluation by the excavation competent person of pertinent factors, such as:
  - Type of soil (i.e., stable rock, Type A, B or C soil) (see Appendix A, Table 1.2 and Glossary).
  - Depth of excavation.
  - Possible variation in water content of the soil while the excavation is open.
  - Anticipated changes in soil from exposure to air, sun or water.
  - Loading imposed by structures, equipment, overlying material or stored material.
  - Vibrations from equipment, blasting, traffic or other sources.
- Since any previously disturbed soil is considered to be Type C soil, excavations in previously disturbed soil (e.g., fill) shall not be sloped at an angle greater than 1½ horizontal to 1 vertical, measured from the horizontal.
- Shoring materials shall be in good condition.

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- Workers shall be trained to look for signs of shoring or sidewall bulge, surface cracking, sand penetration from behind shoring or cracked shoring, which can be a warning sign of a collapse that is about to happen.
- Excavation Planning and Design Responsibilities

Depth	Stable Rock	Soil Type A	Soil Type B	Soil type C
1.2m-2.4m	Excavation Competent person	Excavation Competent person	Excavation Competent person	Excavation Competent person
>2.4m-6m	Excavation Competent person	Excavation Competent person	Civil/Structural Engineer	Civil/Structural Engineer
>6m	Civil/Structural Engineer	Civil/Structural Engineer	Civil/Structural Engineer	Civil/Structural Engineer

- Summary of Soil Type & Maximum Allowable Slope

Soil Type	Descriptions	Maximum Allowable Slope (H:V) Less than 6m Deep
Stable Rock	Natural solid mineral matter that can be excavated with vertical sides such as sandstone.	Vertical (90°)
Type A	Previously undisturbed cohesive or cemented soil, such as clay or marl.	3/4:1 (53°)
Type B	Less cohesive soil, such as mix sand, rock, and clay	1:1 (45°)
Type C	Less cohesive sil, Examples are gravel, muddy or freely seeping soil, submerged rock that is not stable or layered system. Previously disturbed soil.	1-1/2:1 (34°)

5.6.2 Excavation Boxes and Trench Shields

- Portable excavation boxes or trench shields may be used for the protection of personnel instead of shoring, benching or sloping.
- Excavation boxes and trench shields shall be designed, constructed and maintained to provide protection equal to or greater than the required shoring, sloping or benching. The design for custom-made excavation boxes or trench shields shall be reviewed by COMPANY before use.
- Excavation boxes and trench shields shall be installed in accordance with the manufacturer's instructions and to restrict lateral or other movement of the box or trench shield. Excavation boxes and trench shields shall be capable of withstanding any sudden application of lateral loads.
- Excavation boxes and trench shields shall be extended a minimum of 0.45 m (1.5 ft) above the excavation.

5.6.3 Hydraulic Shoring for Excavations

- Hydraulic shoring can be used for protection against cave-ins in excavations that do not exceed 6 m (20 ft) in depth

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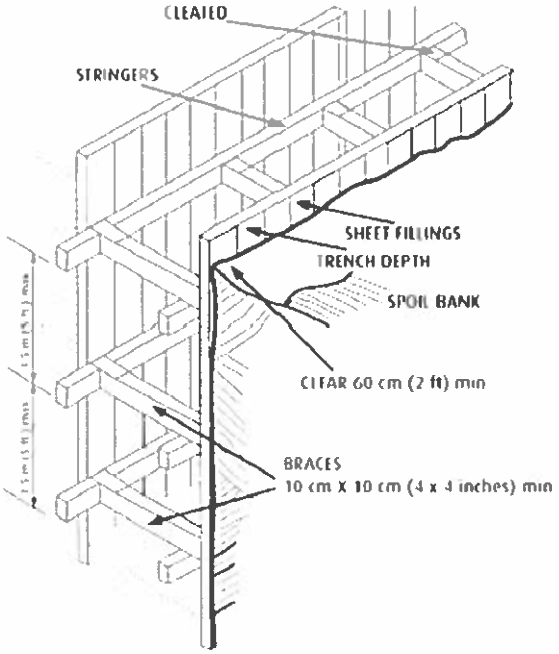
5.6.4 Timber Shoring for Excavations



- Timber shoring can be used as a method of protection against cave-ins in excavations that do not exceed 6 m (20 ft) in depth.
- Timbers shall be sound, free from large or loose knots and have proper dimensions.
- Timber shoring shall be designed in accordance COMPANY Standard Drawing AB-036899. Layout and shoring for trenches not greater than 1.2 m (4 ft) wide and not more than 2.4 m (8 ft) deep.
- Timber used as cross braces or stringers (wales) for shoring shall not be less than 10 cm x 10 cm (4 inches x 4 inches) actual cross-section size. Larger timber braces and stringers may be required, including for excavations in soft or loose soils more than 1.2 m (4 ft) wide or more than 2.4 m (8 ft) deep.
- The cross-section sizes of cross braces, stringers and uprights listed with a bending strength of not less than 850 psi. Use of nominal sizes is permitted only if: (1) all nominal size timber is certified and permanently marked by the lumber mill and/or supplier with a bending strength of not less than 1,500 psi, and (2) shoring layout is per Tables C4 to C6 of ANSI A10.12 or Tables C-2.1 to C-2.3 of OSHA 1926, Subpart P, Appendix C, "Timber Shoring for Trenches."
- Vertical spacing of cross braces and stringers (wales) down the sidewall of the excavation shall not exceed 1.2 m (4 ft), unless a greater vertical

5.6.5 Scaffold Tubing Cross Braces for Excavations

- Scaffold tubing, with compatible screw jacks and base plates, may be used as cross braces for excavations not more than 1.2 m (4 ft) wide and not more than 2.4 m (8 ft) deep. Scaffold tubing shall not be used as stringers (wales) or uprights.

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- For excavations less than 1.8 m (6 ft) deep, scaffold tubing cross braces shall be horizontally spaced not more than 1.8 m (6 ft) apart.
- For excavations between 1.8 m (6 ft) and 2.4 m (8 ft) deep, scaffold tubing cross braces shall be horizontally spaced not more than 1.2 m (4 ft) apart.
- Scaffold tubing used as cross braces for shoring shall have at least a 4.0 mm wall thickness and shall be permanently embossed (stamped) before galvanizing with "BS 1139" or "EN39-4" (Type 4).

5.6.6 Shoring Methods

- Shoring Installation – should be in a top down method.
  - Struts must be in a true horizontal position with the ends secured to prevent slippage or sliding.
  - The uppermost shore must be placed first.
  - If possible, the worker should not be in the trench/excavation when the shores are lowered.
  - To prevent slough off and greater risk of cave-in, the shoring work should follow the trenching and excavation work as closely as possible.
- Removal of shoring – should be in a bottom up method.
  - Workers removing shoring must remain in a protected zone.
  - Premature removal of shoring will expose workers to an unnecessary hazard.
  - Timer or steel jacks are usually removed while inside the trench
  - Before removal, some force must replace the force exerted by the shores against the trench face e.g. bottom and intermediate struts should not be removed until they have been effectively replaced by backfill.

5.7 Edge Protection, Markers Fixed Lighting

- Whenever it is necessary to place or operate power shovels, derricks, trucks, materials, soil banks or other heavy objects near an excavation, the sides of the excavation shall be sheet-piled, shored and braced as necessary to safely resist the extra pressure.
- Only excavating and backfilling equipment (backhoes, front loaders, etc.) are permitted within 2m (6.5 ft) of the edge of an excavation.
- Motor vehicles, cranes and heavy equipment shall be kept away from the edge of the excavation a distance of 2m (6.5 ft) or the depth of the excavation, whichever is greatest, unless the excavation is in stable rock or is protected against collapse by shoring that has been designed or approved by a degreed civil/structural engineer.
- Hard barricades (e.g., concrete or water-filled plastic "jersey" barriers, metal fencing) shall be used to keep motor vehicles, cranes, and heavy equipment at the proper distance away from the excavation.
- When use of hard barriers is impractical inside a fenced COMPANY plant area (i.e., does not involve public access), vehicular traffic near the excavation shall be controlled by flagmen and the excavation shall be flagged with caution tape and well lit for night.
- Pedestrian barricades shall be placed no less than 1m (3 ft) from the edge of the excavation.
- If people or vehicles could be in the vicinity of the excavation after dark, warning lights shall be used to mark the limits of the work. If possible, the grade should slope away from the excavation.

5.8 Excavation Equipment

- All Heavy equipment (excavator, etc.) shall undergo COMPANY Approved 3rd party Inspection prior to mobilization on site.
- Ensure that all Excavation Equipment must have PWAS and RVCCCS
- Audible reverse alarm must be working properly.

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- Equipment cabins must be free of any obstruction to cover the operator 360degree visibility such as cartoons or curtains.
- Workers in the excavation will not place themselves below a load being lifted overhead.
- Equipment must be shut down when the operator gets off the equipment.
- Flagman/Banksman shall be assigned to assist the equipment during operation.
- Knowledgeable signal person (banks man) must be in proper place when equipment operators cannot see the bottom of the excavation.
- Excavation equipment must be operated by trained and qualified personnel only. Equipment operator shall possess valid ARAMCO Certification to operate. A periodic verification of the requirement by the respective HSE Officer shall be conducted and documented.

5.9 Inspection

- A documented inspection shall be performed by an excavation competent person before workers are allowed to initially enter an excavation or after a change in site conditions (e.g., rainstorm, groundwater infiltration, sidewall deterioration, adjacent ground fissuring). For excavations greater than 2.4 m (8 ft) deep, a documented inspection by the excavation competent person shall be performed each morning before workers shall be allowed to enter the excavation.
- An excavation safety checklist shall be used to document these initial/daily inspections (see Attachment 2) shall be completed and signed each day by the excavation competent person. If there is an unsafe condition, workers shall not be allowed to enter the excavation.

5.10 Access & Egress

- Stairways, ladders, ramps and/or other safe means of egress shall be located in excavations that are 1.2 m (4 ft) or more in depth so as to require no more than 7.5 m (25 ft) of lateral travel distance for personnel (i.e., ladders shall be spaced at least every 15 m [50 ft] along a trench).
- Ladders shall conform to the requirements in CSM Chapter II-3, Ladders and Stepladders.
  - Ladders shall rest on the bottom of the excavation and shall extend at least 1 m (3 ft) above the top landing point.
  - Temporary ramps or walkways shall not be inclined more than a slope of one vertical unit to three horizontal units (20 degrees above the horizontal).

5.11 Dewatering

- Employees shall not work in excavations where there is pooled water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees. The necessary precautions vary with each situation but shall include water removal (dewatering) to control the level of accumulating water (e.g., by pumping) and may also include support shield or shoring systems to protect from cave-ins.
- If water is controlled or prevented from accumulating by the use of water-removal equipment, the water-removal equipment and operations shall be regularly monitored to verify proper operation.
- If excavation work interrupts the natural drainage of surface water (e.g., streams), then diversion ditches, dikes or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation.
- Excavations that have been subject to runoff (e.g., from a rainstorm) shall be inspected before use by the excavation competent person.

The following requirements shall always be observed:

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- Dewatering equipment shall be sited in locations that avoid creating of tripping hazards and shall be operated only by competent persons.
- If any diesel/petrol generator is provided as a source of power supply near excavation, then the dangerous exhaust fumes must be ducted away in order to avoid oxygen deficiency.
- Excavations shall be checked daily or before use by a competent person who can recognize signs of subsidence or other evidence of potential failure of the support system.
- The excavation shall also be checked following any inclement weather or other environmental conditions that may affect the integrity of the excavation.
- A project specific register of all excavations shall be maintained including date of back filling and any other relevant information related to the history of the excavation. These records will be kept in the office.
- Suitable and adequate lighting will be provided for any work scheduled during the hours of darkness.

5.12 Backfill

Backfill operations shall be carried out in accordance with the following guidelines:

- Backfilling and removal of shoring shall be accomplished first by backfilling up to a level allowing for the removal of the lower braces. Another layer of backfill shall be positioned in the excavation up to the next layer of braces to be removed. Removal of shoring shall progress together with the backfill from the bottom to the top of the excavation. In unstable soil, ropes shall be used to pull out the jacks or braces from above after all employees have exited the excavation. All excavations shall be backfilled and the surface left in good condition.
- All dump truck will be guided by flagman/banksman during backfilling operation.
- Wheel stopper/wedge will be provided for vehicle dumping material to prevent them over running the edge (fall in excavation).
- Redundant spoil not backfilled will be removed to an area identified in advance.
- A safe system of work will be identified and implemented for the removal of timber supports, steel sheeting and piles. Consideration will include provision of lifting appliances suitable to take the load of embedded sheet piles without damage.
- Civil Manager will ensure that new facilities are clearly reflected in the as-built drawings.

5.13 Hazardous Atmospheres and Materials

5.13.1 Atmospheric Testing

- Gas tests shall be performed per GI 2.709 when there is reason to suspect oxygen deficiency or the presence of a flammable/toxic atmosphere in an excavation.
- When using controls for the purpose of reducing atmospheric contaminants to acceptable levels, gas testing shall be conducted on a regular basis and before the work crew is to re-enter the excavation (e.g., after breaks, lunch) to ensure that the atmosphere remains safe.

5.13.2 Exhaust Gases

- When an internal combustion engine is used in or near an excavation, precautions shall be taken to ensure that exhaust gases are discharged so as not to be a hazard to personnel working in the excavation.

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5.13.3 Hazardous Materials

- When hazardous materials are known or suspected (e.g., sludge, asbestos), excavation work shall not be started until the COMPANY Environmental Protection Department (EPD) is contacted and has evaluated the potential hazard(s) and specified the precautions to be taken.
- If materials suspected of being hazardous are unearthed during excavation activities, all work shall stop until the material is identified by the COMPANY EPD, appropriate removal and disposal procedures are established, and work practices are modified as needed.

5.14 Emergency Response

- Appropriate emergency rescue equipment (e.g., breathing apparatus, full-body harness and lifeline, basket stretcher) shall be readily available during work.
- A standby man shall be in attendance until the work is completed for any excavation that has been determined to be a confined space (see Chapter I-6, Confined Spaces).
- A fire watch shall remain in place any time an ignition source (e.g., welding, cutting) is present in the excavation and for 30 minutes after the ignition source has been removed.
- Personnel entering bell-bottom pier holes or other similar deep and confined excavations shall wear a full-body harness with a lifeline attached to it. The lifeline shall be separate from any line used to handle materials and shall be individually attended at all times while the employee wearing the lifeline is in the excavation. Mechanical devices shall be available on site to lift incapacitated workers from the excavation.

6 REFERENCE

SA-CSM Part II-1 Excavation and Shoring

SA-CSM Part III-3 Electrical Equipment

GI 2.100 Work Permit System

GI 2.709 Gas Testing Procedure

GI 1021 Street and Road Closure, Excavation Reinstatement and Traffic

7 ATTACHMENTS

Attachment 1: Safe Work Instruction in Trenching and Excavation

Attachment 2: Excavation Safety Checklist

Attachment 3: Illustration - Examples of Rigid Goalposts and Barriers

Attachment 4: Flow Diagram on Excavation Works with Underground Services

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Attachment 1: Safe Work Instruction in Trenching and Excavation

Hazards	Risk	Control
Equipment, materials etc. near the edge of the trench	Objects falling onto personnel in the trench causing cuts and lacerations	• All persons entering the trench or excavation to wear a hard hat. • Keep materials minimum of 0.6m away from edge of trench or excavation. • Barricade off any hazardous areas to prevent personnel walking near the edge when work is in progress. • Do not lift materials over personnel.
No access and egress	Personnel falling into the trench causing fractures and lacerations	• An industrial ladder to be provided for access and egress to all trenches and excavations deeper than 1m, at intervals not less than 30m along the trench. • Ladder to be fixed at the top or bottom and to extend 1m above ground level. • To be positioned at approx. 75° to the horizontal. • Any trench or excavation left open without workers being present is to be barricaded or flagged. • All trenches and or excavations deeper than 1.5m if left opened overnight or longer are to be signed "Deep Excavation" and barricaded. • If there is a possibility of access by the public after hours consider using flashing lights around the trench. • Refer also to Safe Work Instruction – Using Ladders
Poor Air quality in trenches	Lack of oxygen or contaminated air causing loss of consciousness, respiratory illness, poisoning	• Ensure plant exhaust does not enter the trench. • Provide mechanical ventilation if there is no natural ventilation and poor air quality is possible. • Provide atmospheric monitoring and testing if poor air quality is possible. • Do not enter a trench where there is a possibility of contaminates, gas leak, exhaust vapors, seepages etc.
Lifting materials and equipment into deep shear sided trenches with plant	Machine striking personnel due to lack of vision causing serious bodily injury	• Banks-man to be present at top of trench to guide operator. • Only authorized personnel shall operate the equipment
Ground water in trench	Egress from trench made difficult during emergency	• Pump out ground water in trench.

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Attachment 2: Daily Excavation checklist

HYUNDAI ENGINEERING & CONSTRUCTION

DAILY EXCAVATION INSPECTION CHECKLIST

Project # _____ **Excavation Location** _____

This checklist must be completed daily and posted on site by the designated "Competent Person(s)" for the excavation. Inspections are to be performed before workers are allowed to enter the excavation each morning or after a change in site conditions (e.g., rain storm, groundwater, sidewall deterioration, or adjacent ground fissuring). At the end of each workday, this checklist is to be given to the contractor's safety supervisor for review and filing. The contractor's safety supervisor is to maintain a consolidated list of all excavations and conduct safety audits of excavations during the course of the workday. All Saudi Aramco safety requirements are to be complied with at all times. The excavation's designated "Competent Person(s)" for the excavation must be knowledgeable of Saudi Aramco's safety requirements and have the necessary training and experience to ensure the work is performed safely.

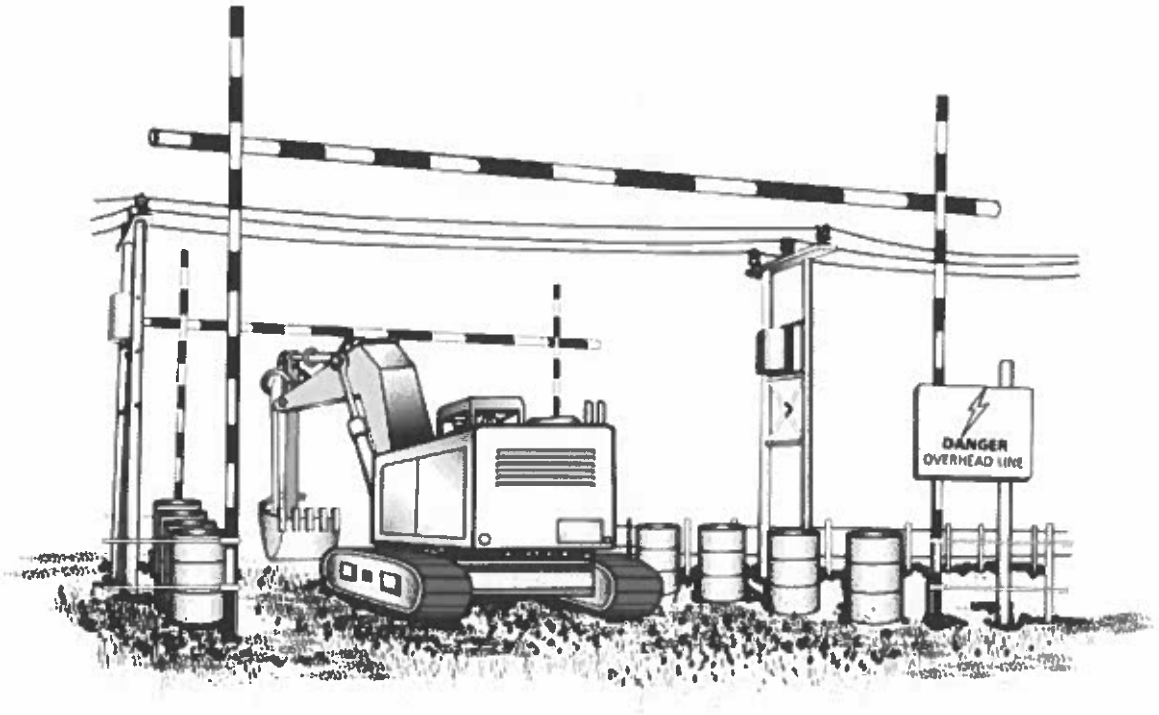
Depth of excavation: _____ **meters / feet**	**Width of excavation:** _____ **meters / feet**		
	YES	**NO**	**N/A**
Has a Pre-Excavation Checklist been completed and is it available on site?			
Have all relevant departments been notified?			
Are underground utilities, cables, and pipelines located and marked?			
Is a Work Permit required, issued, and available on site?			
Is a Confined Space Entry Permit required, issued, and available on site?			
Is gas testing required and performed; e.g., excavations deeper than 1.2 m (4 ft.)?			
Is a Stand-by Man and/or Fire Watch required and available on site?			
Is access to plant equipment maintained?			
If excavation is near a roadway, are flagmen with bright orange vests present?			
Are shoring/sloping/benching acceptable to prevent sidewall cave-in?			
Is shoring material in sound condition and free of damage/defects?			
Is shoring installed/maintained by qualified personnel?			
Are adequate ladders provided within a travel distance of 7.5 m (25 ft.)?			
Are ladders properly secured and do they extend 1 m (3 ft.) above the surface?			
Is excavation free of tension cracks or other evidence of sidewall failure?			
Is excavation free of water, hydrocarbons, or other toxic substances?			
Are materials and spoils set back at least 0.6 m (2 ft.) from excavation edge?			
Are underground utilities and piping located, marked and protected from damage?			
Are pedestrian barricades/lights placed at least 1 m (3 ft.) from excavation edge?			
Are hard barricades for vehicles placed at least 2 m (6.5 ft.) from excavation edge?			
Are cranes not closer than the depth of excavation to the edge of the excavation?			
Are scaffolds erected no closer than 1.5 times the depth of excavation from edge?			
Are overall conditions acceptable and safe for work?			

All deficiencies will be corrected immediately.

_____ _____

Competent Person's Signature ***Date***

Attachment 3: Illustration - Examples of Rigid Goalposts and Barriers



Dimensions:

A: Height to be specified by electricity supplier

B: Width to be determined by site conditions (max. 10m)

C: Height 3-6m

D: 6m (Maximum)

E: 6m (Minimum)

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Attachment 4: Flow Diagram on Excavation Works with Underground Services

This flow is intended to give an understanding of the process from referring to plans on site through the start of excavation, for example when excavating in a road or footway.

However, it:

- Describes only part of the process; it does not, for example, describe planning the work, including reference to plans at the design stage.
- Is a simplified picture and not a substitute for reading the text;
- It is not a substitution for a suitable and sufficient risk assessment;
- Does not take account of a number of other situations, e.g. cables embedded in concrete or those situations where reciting services is proposed.

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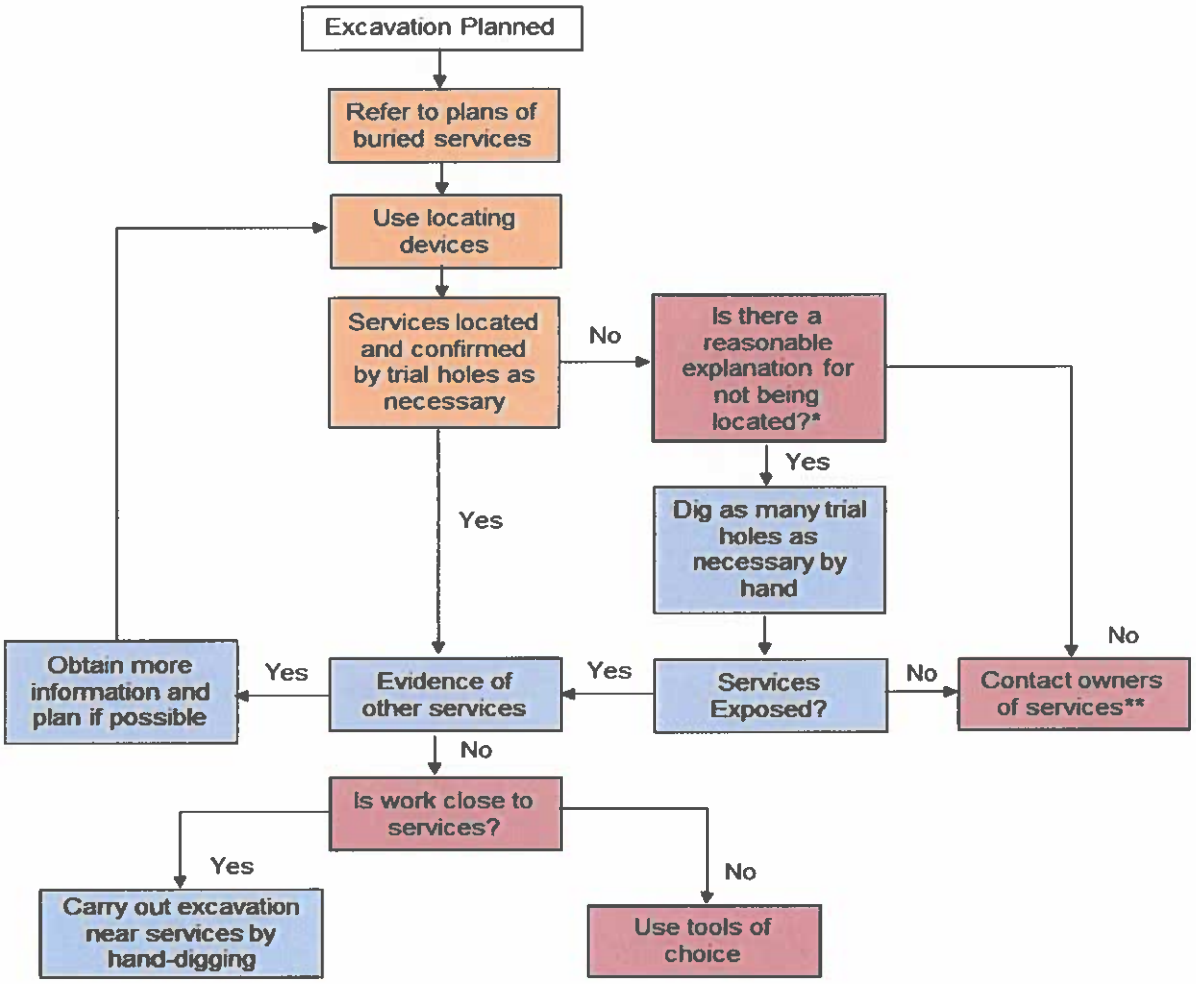

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