Appendix 3: Explanation of different drilling/piling rig uses and specific issues

Drill rigs are characterised by high speed rotation of the drill string and drilled holes are rarely greater than 300mm but can be up to 600mm diameter. Piling rigs work at slower speed and 300 to 1200mm diameter piles are the most common range but can be up to 2500mm. This operational guidance note does not cover driven piling operations (where the drill or pile is not rotated) but inspectors should note that many piling rigs can be readily adapted install both rotary piles and driven piles. In addition to self contained, purpose built drilling and piling rigs there are a range of attachments carried/fitted on cranes and especially excavators that can drill bore holes/install piles.

Drill rigs are used in many industries for a variety of purposes; the main ones are listed below with photographs and specific guidance.

Geotechnical

This covers a multitude of activities including survey and assessment work taking samples or cores at depth to assist with foundation design, looking for water sources and mineral resources, developing geothermal energy systems and designing routes for tunnels. Other purposes include grouting and soil anchoring in unstable areas, rock-bolting, de-watering. Rotary drill units are often assisted by powered impact or sonic wave application. Some rigs are lorry mounted and may have the drill installed centrally within the body which doubles as a lab area. Note that rigs that push the drill string into the ground and only use rotation to crack or make connections are not subject to this guidance.

Many geotechnical rigs can be used to work in the vertical and horizontal planes or inclined between the two; guarding is practicable in all orientations. In inclined or horizontal applications the entire length of rotary drill-string that is within reach will need to be guarded.

Drill mast attachments can be fixed to excavators for geotechnical work; these will also need to be guarded.

One special situation is a geotechnical drilling rig that is fitted with auxiliary (reaction) augers. These are fitted outboard of the main drill or auger string. The auxiliary augers are only used to anchor the rig to the ground. They are drilled (screwed) into the ground at slow speed (much slower than 30 rpm). This allows the vertical load on the main drill to be increased without the rig lifting off the ground e.g. for in-situ soil testing. Auxiliary augers do not need to be guarded when used for this purpose.
Photos 1 & 2: Vertical & inclined drilling rigs, both guarded.

Photo 3: Unguarded (unacceptable) & Photo 4: guarded drill mast attachments on excavators.

Surface production rigs

These are used mainly in quarries and mines to drill holes for explosives to be inserted. This is usually a one-person operation in an excluded area with extra drill sections added automatically from a cassette. The operator does not generally need to come in close contact with the drill string. Lone person working arrangements need to be robust. Drill string guarding and a restricted operating mode is expected and essential if drill sections are added/removed manually.
Appendix 7 provides more information about BS EN 16228 which applies to drilling rigs supplied from late 2014. Parts 1 & 2 are relevant.

**Jumbo tunnelling rigs and rock-bolting rigs**

These have single or multiple articulated arms that can swivel through 180 degrees to drill holes and insert roof bolts or create holes for explosives in blasting to create tunnels. They may also include arms with a manriding access cage.

Photo 6: Guarding jumbos has been problematic and SG advice should be sought if access or work near to the rotating drill is involved and cannot be avoided. BS EN 16228 specifies that jumbo rigs can be supplied without a guard. Where the operator has no direct view of the rotating drill the machine should be fitted with a motion detection trip device to prevent a person approaching. Where drilling is carried out by remote control and the operator...
can see the rotating drill this is not required. See Appendix 7 Part 2 for more information about Jumbo rigs.

Photos 7 & 8: Rock-bolting rigs are rare in the UK but PUWER Reg 11 applies. Seek SG advice if access or work close to the rotating drill string is likely.

Jack-up rigs

This is a floating barge that is manoeuvred into position so that the legs can extend to the river or sea bed below. The barge then jacks itself up to a working position. A range of drilling or piling rigs may be mounted on the barge to carry out survey sampling, piling for flood defences or e.g. jetty construction. Guarding standards are the same as those expected on land but other issues can include access, work at height, transfer procedures, work over water and poor emergency arrangements. Note that it is not practicable to guard the drill string beneath the jack up platform and this area should be managed by exclusion zone.

Once the barge is jacked clear of the water it is HSE jurisdiction and a construction site. CDM etc. will apply as long as it is within GB borders.
Diamond core-drilling rigs

These are towed trailers or lorry or chassis mounted. They are used to drill holes (typically 50 to 750mm dia) usually in concrete slabs or through roadways either for building construction or alterations (e.g. riser installation) or for access to underground services for emergency repairs. A core drill mounted on a trailer or chassis or lorry should be guarded. The rigs shown are trailer mounted which makes guarding practicable.

A developing technology is self contained core and vac machines. These are used for gaining access to underground services by retrieving a core from the road structure for use in reinstatement. An air spade and vacuum unit then removes underlying material to allow remote ‘key hole’ service inspection, maintenance, termination or new connections to be carried out without needing to ‘dig up’ the road. These units should have guards in place during rotary works. Appendix 7 provides more information about BS EN 16228 which should be applied to core drilling rigs supplied from late 2014. Parts 1 and 2 are relevant.

Smaller core drills are available that are stand mounted, and are typically bolted to the floor or wall to be drilled through. Traditionally these small, lightweight units have not been guarded and until tool developments make guarding more practicable they can be used with exclusion barriers rather than interlocked guards. When core drilling floors the exclusion zone needs to extend to the area below as a through core, once free, tends to fall clear. A stand mounted drill is preferable to a hand held unit especially when core drilling multiple holes in concrete.
Horizontal directional drilling (HDD) rigs

These are a form of trenchless technology gaining in popularity due to the ability to insert utilities pipes without the need to excavate along the route. Pipelines of over 1m diameter can be installed by large HDD rigs using multiple passes to ream out an initial small diameter hole. Whilst it is practicable to guard the areas of drill string accessible down to, and including, the ‘rocking’ clamps, the area of drill string protruding beyond this and into the ground must be managed by the contractor. HDD rigs may use ground fixation augers to anchor themselves to the ground. The ground anchors rotate briefly at slow speed during set up. If they are on hold-to-run controls and within full view of the operator then guards are not required. See Appendix 7 Part 3 for more information about HDD rigs supplied after late 2014.
Photos 14 & 15: On models such as these the drill string is more exposed and must be guarded. The contractor on site is responsible for guarding arrangements between the machine drill string guide/clamp and the area of entry into the ground.

Photos 16 & 17: On very large HDD rigs the rocking clamps must also be guarded and if there is a walkway along the drill string access to the rotating part must be prevented – a fixed barrier may suffice. It should not be possible to reach rotating parts from the ground or while on the machine access platforms (but see Appendix 7 Part 3 regarding the operators zone of influence).

Mini-piling rigs

The rotating drill string of mini piling rigs must be guarded. Mini rigs are characterised by their relatively low centre of gravity, limited height and versatility. Mini rigs have: a torque less than 35kNm, a multi-directional drilling capability and typically the process involves adding and removing drill rods, tubes, casing or augers, which are normally threaded.

There are two main arrangements. Some have a leader (mast) and are most effective when they can drill to full depth without adding drill sections. Others add auger sections manually or with powered winch assistance. Typically, these are in approx 1m lengths and adding or removing sections requires continual access to the drill string. Most do not have a cab and the operating
position can be close to the rotating drill/auger. The combination of these features sets mini rigs apart from full size drilling/piling rigs.

They are often used in restricted access or low headroom areas such as existing buildings to produce cast in-situ piles. Operators will frequently attempt to work without guards to enable them to work closer to existing walls or other obstructions. This increases the risk of them being crushed against the structure if they become entangled. Some units can be operated by remote control.

The designer, structural engineer and client should be challenged under CDM duties to remove risks at the design stage and to re-visit the design accordingly. Can pile locations be moved? This may involve deeper piles or cantilevered slabs / beams.

Also, if trying to work around obstructions ask whether an intelligent guard design could be accommodated to allow access for tool changing / cleaning. Concertina doors, side-opening gates, cylindrical rotating gate designs can facilitate guard use in restricted spaces. Under these circumstances, it may not always be practicable to interlock all parts of the guard.

Appendix 7 provides more information about mini rigs supplied from late 2014 when BS EN 16228 parts 1 and 2 will apply.

Photos 18 & 19: Mini Rigs - Sliding and side opening guard designs.

Other types of piling equipment

Driven piles - Piling operations using rigs or piling attachments that drive a pile into the ground do not usually involve any rotation and therefore rotary entanglement is not an issue. This type of equipment is outside the scope of this guidance but note that some equipment is readily adapted to work in driven or rotary mode.
Bored piles - use a short auger on a long stem that drills into the ground to load the auger and is then repeatedly withdrawn, slewed off bore and spun to remove the spoil. Exclusion zones may need to be fenced but guarding is neither practicable nor necessary due to the system of work operated. Casings may be used to line the pile bore in loose ground and these are pushed into the ground and may be rotated at times. The speed of rotation is slow (less than 30rpm) and entanglement or access to inrunning nip points is prevented by exclusion zone.

Continuous flight auger (CFA) piling - use an auger that extends the full height of the drill string. This is drilled into the ground whilst rotating in one pass and then withdrawn, whilst the auger is slowly rotating. During withdrawal concrete is pumped down the hollow stem of the auger to maintain a positive pressure ahead of the auger. As the auger emerges slowly from the ground, spoil trapped in the flights is removed, using a mechanical auger cleaner, or by the bucket of an attending excavator (which also involves slow rotation of the auger). The auger should not normally be cleaned by hand. If a contractor argues that they need to pull spoil off the auger by hand this may only be done while the auger is not rotating.

Personnel may only be close to the auger while it is not rotating. Powered auger cleaners also present a separate risk of entanglement. If the powered cleaner is within reach there should be no access during operation. CFA rigs use a clamshell guide to support the auger close to the ground while drilling is started. This is usually no more than 600mm high. BS EN 16228 (part 4 clause 5.4) exempts CFA rigs from the guarding specification if they either have a lower auger guide (which needs to be opened to allow the drilling head to descend to the ground - most do), or if they are fitted with an auger cleaner that moves vertically. For this exemption to apply rotation speed must be less than 30rpm. The supervised system of work must ensure that approach during rotation does not occur. See Appendix 7 Part 4 for more information about CFA rigs.

A recent development of the CFA process is the cased CFA rig in which the auger rotates within a full height casing. The casing rotates at low speed (less than 30rpm) and cuts its way into the ground. Spoil emerges from the top of the auger and is carried to the ground via a telescopic chute system. An exclusion zone should be operated during drilling and concreting with no access allowed to inrunning nip points.

Pole Rigs

These are typically used by utility companies to auger holes for the erection of lamp standards or utility poles. Typically they are mounted on LGV chassis and include a loader crane with an auger attachment. Traditionally the augers on these rigs have not been guarded. The speed of rotation is slow (less than 30rpm) and entanglement or access to in-running nip points is prevented by
exclusion zone. The declaration of conformity for such equipment typically cites the loader crane standard BSEN 12999 and or the MEWP standard BSEN 280.

Auger attachments are also available for agricultural machinery and excavators and may be found on construction sites installing fence posts etc. On small units where the auger is not guided but is simply rotated it is unlikely to be practicable to fit a guard and protection should be by exclusion zone. On some attachments the auger is able to swing to the side even though the primary use is for vertical holes. Once in the ground side movement should not occur but starting a new hole can cause the auger to run. Where this is possible, the operating position should not be within reach of a swinging auger.