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**RUWAIS REFINERY
EXPANSION PROJECT**

**EPC-4 TANKAGE AND ASSOCIATED
INTERCONNECTING PIPING**

AGREEMENT No. 09-5578-E-4

DAEWOO E&C

PROJECT No. 5578

Doc. No. 5578-E4-HSE-HU-00042

Rev. 0

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MACHINE, POWER & HAND TOOLS SAFETY

AGREEMENT NO. : 09-5578-E-4

**PROJECT NAME : Ruwais Refinery Expansion Project
EPC-4: Tankage & Associated
Interconnecting Piping**

COMPANY : Abu Dhabi Oil Refining Company (TAKREER)

PMC : Mott MacDonald Ltd.

CONTRACTOR : Daewoo Engineering & Construction Co., Ltd.

PROJECT No. 5578

Doc. No. 5578-E4-HSE-HU-00042

Rev. 0

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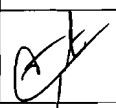

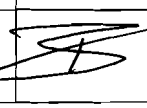
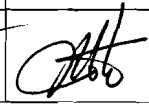
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NOTES:

- Revisions are denoted by a vertical line placed in the right-hand margin against the revised text.
- PREP = Prepared by, CHKD = Checked by, REVD = Reviewed by, APP'D = Approved by.
- In case of conflict between any requirements stipulated in this document with the contractual requirements, the contractual requirements shall prevail.

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1. INTRODUCTION

1.1 Purpose

This procedure defines requirements for the safe operation of machine and hand tools used in all DEC Projects.

1.2 Scope

This procedure is applicable to DEC, subcontractors, vendors and all personnel performing work on the project.

2. RESPONSIBILITIES

2.1 Project Manager

The Project Manager is responsible for ensuring that the requirements of this procedure are adhered strictly to during execution of the project.

2.2 Section Manager

The Section Manager is responsible for ensuring that;

- Monitoring and checking of the compliance of this procedure
- All the Machine and hand tools used on the site have been inspected and are safe to use.
- Manpower, equipment and funds are available to purchase, use and maintain the machine, power & hand tools.

2.3 HSE Manager

The HSE Manager is responsible for ensuring that, all machines and power tools shall meet Korean or international standards and personnel are fully trained & aware of the safe use.

- Proper training is conducted
- Toolbox meeting is conducted.
- JSA is applied.
- All identified necessary work and precautions are properly executed.

2.4 HSE Supervisor

The HSE Supervisor is responsible for

- Ensuring that JSA related to activities are properly conducted.
- Ensuring that operating manuals for particular machine equipment are available.
- All defective tools should be replaced or discarded from the site and store.

2.5 Supervisors

The Supervisors are responsible for safe operation of all machine and hand tools used by his crews. All crews have adequate training and experience to work with the hand and machine tools.

3. GENERAL SAFETY RULES FOR OPERATING MACHINES

The use of machine and hand tools, in inexperienced or untrained hands, is a prime cause of incidents and occupational illnesses in any industry. These incidents are preventable if the operators are properly trained and equipped with the correct PPE, and the safety guidelines are followed. The following procedure will define these guidelines which must be followed for work in DEC Projects.

Only authorized and qualified machine operators/maintenance personnel are permitted to work on machine tools. Never operate service or adjust any machine without proper training and without first reading the instructions in the owners or manufacturers machine manual. One shall be familiarized with the location of all emergency stop switches.

Check that all machine guards and safety devices are fitted before operating any machine tools. Never tamper with or make any adjustments to manufacturers guards or safety devices.

Report all defects of machine tools to your supervisor immediately once they are discovered.

Never carry out any cleaning or maintenance work while the machine is in motion. Disconnect or isolate (lockout / tag-out) the power source to ensure the machine cannot start whilst carrying out these operations.

Never leave moving machine tools unattended.

Never place hands or any part of the body near rotating machine tools, moving chains, gears, etc.

As with all rotating machines, loose fitting clothing, loose fitting gloves & cotton gloves or jewelry such as bracelets and rings should not be worn as these can easily be caught on revolving machine parts which would cause serious injury by dragging a hand or arm into moving machinery.

Persons with long hair should have it secured by a close fitting hat or net.

Always wear approved PPE as per the job demand and recommendation of equipment's manual i.e. eye protection while machining to protect the eyes against flying pieces of steel chips, abrasive grains or even broken pieces of cutting tools. Never wear cotton gloves, or rings when working on machine tools. Gloves should only be worn when handling sheet metal, heat resistant steel foil and sharp edged pieces of raw materials.

When in doubt about the requirement of PPE ask your supervisor.

Maintain good housekeeping in the working area to eliminate slip/trip hazards. Passage ways and floor area around the work place shall be kept free of oil and grease. Raw materials and large work pieces are to be stacked in an area away from machines.

Obtain assistance when mounting a heavy machine part or heavy work piece, or use a proper lifting device.

4. DRILLING MACHINE SAFETY

The work piece must be securely clamped or bolted to the drill table during drilling to avoid accidents if the drill jams, this would otherwise cause the work piece to suddenly rotate.

Do not apply excessive pressure on the drill. Re-grind or replace blunt drill bits.

Only the correct chuck key must be used and this must not be left in the chuck. The adjustable guard must be designed and fitted so as to render the chuck and the length of drill not entering into the work piece inaccessible to the operator when the drill is running.

Use a stiff brush to remove swarf (drill cuttings). Not your hands! Store all waste correctly for later disposal.

5. LATHE/MILLING MACHINE SAFETY

To avoid cutting swarf becoming wrapped around the work piece use only cutting tools with a chip breaker ground in to the tool. Stop the lathe or milling machine to remove swarf with a stiff brush or wooden handle. Dispose of swarf to a closed container.

Extreme caution must be observed when changing lathe chucks or some milling machine attachments, since these are heavy. Obtain assistance or use a lifting appliance to avoid back injuries.

Handle lathe and milling cutters carefully to avoid cuts.

Wait for machines to stop completely before taking measurements.

6. GRINDING MACHINE SAFETY

Before mounting a new wheel test it for soundness and inspect for cracks e.g. ring test. Ensure the wheel is the correct RPM rating for the machine, this must be marked on the wheel and the machine, for all disks over 55mm in diameter. Ensure the wheel is mounted correctly by a qualified user.

All guards and protective hoods are to be in place and tightly secured. Guards, so far as is reasonably practical, should be so made that they can contain a wheel if it fractures. With the power source disconnected/isolated turn the wheel by hand to check for clearance.

The grinding machine must be fitted with efficient stopping and starting devices conveniently situated.

Before switching on the machine ensure the table is secured and adjusted as close as practicable to the wheel. Ensure the work piece is rigidly supported and firmly clamped.

Allow the wheel to test run at full speed for at least a minute before starting actual grinding.

Never place your hands near revolving wheel or use them or any other device to stop the wheel after switching off.

Avoid grinding on the sides of straight-sided wheels and the use of warped cut-off wheels.

Abrasive wheels should be stored in an area, which does not become excessively hot or excessively cold and the area should always be kept dry.

Dust masks must be worn when grinding unless the machine is fitted with an adequate dust extractor.

7. RULES FOR THE SAFE USE OF HAND TOOLS

It is the duty of management to make available the appropriate tools, to ensure that operatives are properly instructed in how to use them and to provide competent supervision to ensure that work is correctly and safely performed.

7.1 Quality

Buying cheap tools is a false economy. They do not last and they can become dangerous, effort must be made to ensure tools are of good quality.

7.2 Handles

Handles are necessary for ease of manipulation and for protection of the hands. Depending on the tool in uses they should be of good quality plastic or well-seasoned ash or hickory, of smooth finish and firmly fixed. They should be regularly checked for splits or cracks and wedged where necessary to keep them tight.

7.3 Cleanliness

Grease, moisture and dirt should be regularly cleaned off. Any movable and adjustable parts should be lightly oiled to protect against corrosion and to prevent wear and misalignment. Tools made of cast steel or cast iron is less liable to crack in cold weather if kept clean and dry.

7.4 Cutting Edges

Cutting edges should be kept sharp to permit accurate working and to avoid the hazards arising from unnecessary pressure. Sharpening is a relatively skilled job - good carborundum or oilstone should be used. Saws are usually sharpened using a machine grinder or hand file. Where abrasive wheels are employed only a little of the edge should be ground at a time and the tool rest kept close to the wheel. The tool itself should be held lightly to prevent overheating and cooled with water to retain the hardness of the metal.

7.5 Inspection

All hand tools shall be inspected periodically and color coded.

7.6 Storage/Repair Tools

These should be regularly checked and thoroughly examined before storage and, if worn or damaged, they should be properly repaired or discarded. When not in use, tools should be stored in boxes or racked, cutting edges should be sheathed. Tools should be kept clear of walkways so as not to present a tripping hazard.

7.7 Selecting the Right Tool

Every tool has its proper application. The correct type, size and weight of tool should be selected for the job. To misuse a tool, or to use the wrong tool, is to invite damage or personal injury and is a violation of site regulations.

7.8 Electrical Risks

All metal tools are conductors of electricity. Where work takes place on, or near, electrical apparatus, only properly insulated and non- conductive tools should be used. Insulation and, where appropriate,

ground continuity, should be tested at regular intervals by a competent electrician. Current should be switched off if possible.

7.9 Sparking Risk

For work near highly flammable materials or explosive gases/dusts, special tools, made from non-ferrous metals, e.g. beryllium (copper alloy) are required, since a spark could cause fire or explosion. Spark-proof tools should be regularly inspected in case steel splinters have become embedded and need grinding out to ensure continuing safe usage.

8. INDIVIDUAL TOOLS

8.1 Screwdrivers

- Screwdrivers are one of the most commonly used tools and are frequently misused and abused - they must not be used as chisels, drifts or wedges.
- A screwdriver should be of the correct size to fit a screw head and its tip should be properly ground to fit the slot.
- The work should be held firmly and a steady, even pressure, exerted on the screw. Undue force is unnecessary. A screw properly fitted draws itself into the correct position. When it is known that screws will have to be removed, they may be greased to assist withdrawal.
- Care should be taken not to mix crosshead screws of the Pozidrive and Phillips type since the incorrect screwdriver may slip.
- Over tightening can be dangerous - it can lead to hand damage if the screwdriver slips, or overbalancing if work is being done from a ladder.
- Some modern plastic-handled screwdrivers have sharp castellated grips, which are uncomfortable to use and cause blisters. These handles should be fitted with the correct rubber grip.
- Screwdriver shanks are not designed to withstand twisting strain from pliers or grips, which are often mistakenly applied to obtain additional leverage on a "stubborn" screw.
- Screwdriver handles will not withstand hammering. They are likely to become uncomfortable to use and frequently will split or break.
- Serious puncture wounds can be sustained as the result of carrying screwdrivers in the pockets of clothing or overalls.

8.2 Hammers

- Heads of all hammers should be firmly and accurately set on the handle. If the handle is loose, it will fly off when a blow is struck: if it is inaccurately set, blows can be missed and fingers damaged.
- Hammerheads should be secured to handles with proper wedges and kept in shape by occasional grinding. Heads, which show any signs of cracks, should be discarded immediately to avoid the risk of flying splinters.

- Avoid using hammers with heads bonded to handles with epoxy resin as the cross section of the shaft has often been over-reduced during fitting. Handles should be smooth and free from splits.
- Glass-reinforced plastic handled hammers should be inspected for stress cracking. Steel-shafted hammers should be inspected regularly at the joint between the shaft and head. Rubber composition handles must be securely fitted and the bond regularly checked.
- It is essential that the right kind of hammer for the job be used. An engineer's (ball point) hammer, for example, which has a striking face rounded at the edges to prevent chipping or mushrooming, is not suitable for driving nails and can result in crushed fingers or flying nails.
- "Soft" hammers with heads of lead, copper, rawhide, plastic or rubber are available for work on particular surfaces. They permit the force of the blow to be transmitted to the work whilst acting as a shock absorber. In this way the work surface remains undamaged.
- Cartridge hammer pins should not be driven using joiner's (claw) or engineer's hammers. The manufacturer's hand driving tool should be used.
- Where drifts are used to take hammer blows, the drift heads should be in good condition or damage can occur from flying pieces when a blow is struck.

8.3 Cold Chisels

- Chisel and bolster cutting edges should be kept sharp and the original shape and angle maintained. Re-sharpened chisels should be suitably hardened and tempered to keep them in safe working condition.
- Chisel heads mushroom with use. When mushrooming develops, heads should be reground: a slight taper around the edge helps to reduce the tendency to mushroom and increases the safe working period between necessary repairs.
- Cold chisels can be purchased with a safety grip, which reduces the likely hood of serious hand injuries.
- It is important to select the correct size and type of chisel for the job and a hammer of the correct weight.
- Chisels should be held in a steady, relaxed grip, the depth of the cut being regulated by the angle at which the chisel is held. The operator should keep his eyes on the cutting point.
- Cutting and chipping work should be done with the sharp edge pointing away from the worker.
- When small pieces are to be chipped, they should be held by a vice, clamp, etc. so that the worker has both hands free for his job.
- On large work, where a sledgehammer is to be used, the chisel should be held in tongs at right angles to the line of striking.
- Chisel work can result in flying chips and splinters: eye protection is vital. Screening may be necessary to protect others working or passing nearby.

8.4 Files

- Files are made of high tempered metal, which will shatter if struck or subjected to leverage.

- The correct type, cut and size of file should be selected for the job.
- Filing hard metal makes the cuffing teeth smooth: filing soft metal clogs them. Both kinds of work result in the file becoming smooth, which can lead to slipping and damaged hands. To avoid undue wear on the file teeth, grinding may be preferable at first if there is much hard metal to be removed. Frequent cleaning of the teeth with a file card is necessary when filing soft metal.
- Small work pieces should be secured in a vice or clamp. Larger work should be made steady. If the work is slotted, twisting of the file should be avoided to eliminate the risk of its shattering.
- Handles must be fitted to all files to avoid damage to the hands or body. Handles should be of the right size for the file with a hole of the correct size for the tang. When the tang is inserted, the handle should be tapped on a hard surface to drive it on the tang. If the file is hammered into the handle, the file may shatter.
- Files should be kept free of oil and grease and not allowed to become rusty. When not in use they should be wrapped in dry paper or cloth.

8.5 Picks and Shovels

- Work is more easily tackled when picks and shovels are kept clean, in serviceable condition and with handles free from cracks and splinters.
- Shovel blades should not be allowed to become blunt, turned, split or jagged.
- Pick head points should be kept sharp and heat-treated so that metal wears down in use and does not splinter or chip off. Pick heads must be firmly set on handles.
- When using a pick, the user should spread his legs to get firm footing and strike the blow so that the point of contact is within easy reach, but not too close to his feet. The wearing of safety footwear, with steel toecaps, is essential.
- The surrounding area, including overhead, must be clear of obstruction and other people.
- Neither picks nor shovels should be left lying around. They are a severe tripping hazard.
- If the tool has splintered or cracked shafts it should be immediately removed from service.

8.6 Spanners (Wrenches)

- Carelessness and misuse of spanners (wrenches) causes damage to hands, arms and backs and can damage the material worked on.
- Spanner lengths are graded to provide sufficient leverage on the nut for which they are intended. An attempt to increase leverage on spanners, of the open- end type, only causes stripping of the bolt thread or snapping of the bolt and increases the hazard of slipping or falling for the user. Only spanners of the right size should be used and the jaws should be first checked for any sign of opening out or other damage.
- Adjustable spanners should have square and undamaged jaws, and the adjuster nut must work smoothly and not be cracked. Adjustable spanners are likely to crack if struck with a hammer in trying to free over tight nuts.

- Pipe wrenches must be large enough for the job, with the jaw teeth clean and sharp and with the knurl, pin and spring undamaged. Like adjustable spanners, these wrenches will not withstand hammer blows.
- Care should be taken that the grip on a spanner (wrench) will not endanger the user should the tool slip - this is especially important for overhead work.
- After use, spanners (wrenches) should be cleaned and any moving part lightly oiled before being stored in a toolbox or rack.
- Spanners are not hammers; misuse can result in dangerous failure of the tool.

8.7 Pliers

- Pliers should only be used when there are no other tools for the job. Slip-joint pliers are meant for gripping round objects only. Pliers, misused as spanners, damage nuts and bolts. Pliers are not designed as nail pullers or pincers.
- Cutting pliers are available for soft metal, but care must be taken to ensure that the cut portion does not fly off. When wire under tension is to be cut, there is always danger of the ends flying and eye protection must be worn. Long handled pliers are better for this work. Gloves should be worn.
- All pliers should be kept free from dust and grit, and with movable parts lightly lubricated.
- Rivets or bolts and nuts holding parts of the pliers together must be kept sufficiently tight to ensure efficient working.

8.8 Woodworking Tools

- Sharp edged woodworking tools should be kept sharp so that, in use, undue force is not necessary. Sharpening should be done correctly, according to type, using either an oil stone placed on a flat, stable surface, or a grindstone on which the direction of rotation is away from the body. In the case of a saw, a file and saw set is used.
- A mallet should be used with a wood chisels, rather than risking splitting the handle with a hammer. The mallet should be used no more than necessary to make the chisel move easily in the work.
- When not in use, all sharp edged tools should be racked edge downwards on the bench, or have the edges protected by sheaths, to avoid accidental cuts. The cutting edge of planes may be protected by retracting the blade into the plane, placing the plane on its side, or by placing the leading edge of the plane on a block.
- There are many different kinds of woodworking handsaws, each with a particular type of cutting teeth. Selection of the proper type for the job is most important.
- Saw teeth should be properly set to avoid binding in the cut, causing the blade to buckle and possible injury to the user.
- Timber to be cut should be free from nails, etc., which might throw the saw from its cutting line.
- To avoid injury to thumb or forefinger, the cut should be started by drawing the saw upwards until it bites into the wood, using the thumb of the disengaged hand as a guide at the side of the blade. The saw should be handled firmly and the cut started slowly so that the saw cannot jump.

- Timber being cut should be firmly supported and, if necessary, wedges should be placed in the cut to prevent the saw from binding or pinching.
- Particular care is necessary when sawing in elevated positions to prevent persons below being struck by cut offs.
- When saws are not in use, the teeth should be cleaned and the blade wiped with a slightly oiled rag to prevent rust. Saws should be protected, preferably by a full sheath, but at least with the teeth covered by a slotted piece of wood.
- Two-man crosscut saws should be operated by pulling only, in teamwork with a partner. The cut should be kept straight to avoid buckling and, as these saws are only used on tree trunks and heavy timbering, it will frequently be necessary to wedge the cut to prevent pinching.
- When axes or adzes are in use, there should be enough clear space for a full swing and the working area should be free from obstructions and tripping hazards.
- When using an axe, the feet should be well apart to affect a steady stance and a long grip on the handle is necessary.
- When adzes are used, the work should be set between the legs, spread wide apart and cutting strokes should be made by gentle swings cutting straight back. Cross or angle cuts should be avoided to prevent leg injuries.
- Where draw knives or spoke shaves are used, the work should be rigid. It is possible that the shape and width of the work will ensure its immobility, but if there is any doubt, it should be clamped, braced or secured in a vice.

8.9 Knives / Machetes

- Knives should be kept sharp - the excess pressure necessary to use a dull knife is likely to result in injury if the knife slips.
- Many knives have been specially designed to permit controlled usage in many different types of work e.g. the hooked linoleum knife for cutting floor covering. Most specialized types of knife work require that the users are properly trained in the correct cutting motions.
- A "cutting stick" should be used in conjunction with machetes to provide extra protection against cuts to the legs of the user. The stick, similar to a walking stick, is held against the ground in the left hand, if the user is right handed, and protects the user's legs from over swinging. Machetes should always be swung in away from the body and legs.
- When not in use, knives and machetes should be sheathed, the blade retracted, or placed in slotted racks. If knives or machetes have to be carried, they should be sheathed, or a least held point downwards.
- Razor type blades should only be used in special holders.

8.10 Punches

- Punches should be straight and heavy enough for the work. Points of center punches should be kept accurately ground. Pin punches and starting punches should be kept squared.

- The tools should be held firmly, especially on rounded surfaces and punches should be started with light taps.
- If rivets and pins are to be knocked out, work should begin with a starting punch and finish with a pin punch.

8.11 Jacks

- Jacks must be heavy enough and strong enough to raise and maintain the load. They should be placed on firm, solid support. The load should be on the centerline of the jack.
- Once a load has been raised, it must be shored or blocked and the security of the load must not depend solely on the jack. If a locking ring is provided on the jack, it should be adjusted each time the jack is raised.
- Jacks should be inspected and lubricated regularly and stored in a dry atmosphere to prevent rust. The correct hydraulic fluid must be used in jacks. Where there is a separate hydraulic pump, it must be ensured that the hose connections and gauge are in good order.

8.12 Hacksaws

- The correct type of blade should be selected to suit the material to be cut, teeth should be set in the frame, and pointing forward and sufficient tension should be applied to keep the blade rigid without distorting the frame.
- In use, strong steady strokes should be made away from the operator and the full length of the blade should be used in each stroke. Hard materials should be cut slowly.

9. POWER TOOLS - GENERAL

Many jobs can be done faster, more efficiently, even more accurately, and certainly more economically, using power tools. Operative fatigue is reduced. It is essential, however, that these tools are only used for those jobs for which they were designed. It is the responsibility of management to provide the proper tool for the job and to see that it is properly used.

Manufacturers and/or suppliers should always provide Information concerning the safe use of tools.

The efficient and safe use of all powered tools can only come through proper training, proper maintenance and from adequate supervision on site. Too many accidents have occurred through the use of these tools by untrained unskilled labor. With the more potentially dangerous equipment, e.g. portable saws, cartridge tools and portable grinders, even qualified tradesmen should be given specific instruction.

Power for this type of equipment can be supplied from:

- Compressed Air
- Explosive Cartridge
- Electricity
- Internal Combustion Engines.

There may be little to choose between the efficiency of tools operated from any of these sources, but there are sometimes other considerations to be taken into account, e.g. the electric breaker is quieter in operation than its pneumatic counterpart because it has no exhaust noise. Such tools are therefore more suitable for use in some confined spaces where exhaust fumes and the noise level would otherwise become dangerously high. These advantages must be weighed against the dangers of using electrical tools in certain confined spaces, such as steel vessels.

The continuing efficiency of all portable powered tools, like all other mechanical equipment, depends on regular care and maintenance. Tools should be regularly checked on issue from, and return to their tool store.

All tools, which have exposed cutters should be switched off and held until they have stopped moving before being set down.

All tools with interchangeable parts must be isolated from the power source (unplugged) before any changes are made.

Operators should not wear any items of loose clothing, which could become caught in moving parts of power tools.

9.1 Noise

Excessive noise is a hazard in the use of many power tools, particularly pneumatic. Noise should be reduced, as much as possible, at the source. Compressors should be of the quiet type or at least have sound reducing covers, which should be closed when running. Suitable silencers should be fitted to tools, e.g. exhaust mufflers to concrete breakers. Where persons are exposed to a noise level exceeding 85 decibels, hearing protection must be provided and worn.

9.2 Vibration

A number of tools are associated with the incidence of Vibration White Finger (Raynaud's phenomenon of Occupational Origin). The initial symptoms of this injury are a slight tingling or numbness in the fingers and this may pass unnoticed. Later the tips of one or more fingers most exposed to vibration suffer attacks of blanching (whiteness), the attacks being more frequent in cold weather and early in the morning. Attacks of VWF typically last about one hour, ending with a sudden rush of blood to the affected fingers and frequently considerable pain. If prolonged exposure to vibration continues, the fingers may take on a permanent blue-black appearance and, very rarely, gangrene of a finger may occur.

These tools include pneumatic hammers and drills, chain saws, pedestal and hand-held portable grinders, Chipping hammers and concrete vibro-thickeners. Vibration exposures from such tools may be reduced by the wearing of gloves, padded at suitable points with absorbent materials.

Certain tools, for example chain saws, are available in an anti-vibration form, and design modifications of tools to reduce vibration level appear to be the only satisfactory way to combat VWF.

10. PNEUMATIC TOOLS

Compressed air is delivered at high pressure. If it enters the body, it can rupture internal organs and may cause death. Any form of horseplay is expressly forbidden under all circumstances.

10.1 Compressors

The compressor itself should always be under the supervision of a competent person who should be responsible for ensuring that the guards for the V-belt and pulley drive are in place and also for the regular inspection of the necessary hoses and couplings. A check must also be made that the oil feed to the airline is properly topped up. Compressors require adequate ventilation and special provision therefore needs to be made when compressors have to be sited in confined areas.

Air receivers must be marked with their safe working pressure and distinguishing number; they must also be fitted with a safety valve, pressure gauge, drain cock and manhole. Air receivers must be cleaned and thoroughly examined at least every 26 months.

10.2 Hoses

All compressed air hoses must be the right size for the tool: if the bore is too small, insufficient power will be supplied. The length of hose should be kept as short as possible: it should be kept free from corrosive materials and leaks and protected from damage by passing traffic.

If work is to be undertaken at some distance from the compressor, the safest method of ensuring efficiency is to use large bore pipe most of the way, then to fit a shut-off valve where the normal bore feed to the tool begins.

When not in use hoses must be kept clean.

10.3 Connections

All connections must be properly clamped, i.e. Chicago coupling, double bolt clamp because loose connections can blow off causing the hose to whip back and cause injury. It is also dangerous to over tighten the connections because this can result in the hose being cut, causing leakage and loss of power. Safety devices (whip check) must be used at all connection points, which restrain connectors in the event of a blow-off, are available: alternatively, double lock couplers may be used.

10.4 General Precautions

- Tools require clean air and proper lubrication. Therefore, in every airline, there should be an efficient filter and lubricator.
- If any fault develops, the main air supply should be shut off and air cleared from the tool before any investigation takes place: otherwise a disconnected coupling may snake off and cause injury.
- Oil mist from the tool exhaust can cause offensive, if not dangerous atmospheres in confined space such as deep trenches, tunnels and headings. Good ventilation is essential in such cases.
- All tools should be held firmly to prevent them from spinning and jumping, and firm pressure should be maintained in the same way when stopping and starting, so that no damage can be caused to the operator's feet and hands.
- In cold weather, pneumatic tools may freeze up. An anti-freeze lubricant in the regular oil-fog lubricator fixed in the airline, usually on the compressed air outlet, will overcome the problem.

10.5 Individual Tools

Concrete breakers

The retaining spring should always be securely in position to prevent the point dropping out and falling. It is essential to keep the point properly sharpened, because a blunt end tends to skid in all directions. It

is equally important that the end is properly heat treated because, over a period of time, the temper of the metal is reduced and the end can break off and severely damage the operator's feet. It is mandatory that operators always wear steel toe-capped safety footwear.

Rock drills

It is extremely important that the operator adopts a secure foothold, well balanced posture and uses both hands. Any other method of using the tool creates body hazards and the risk of losing foothold.

Air Grinders

- Air Grinders must be fitted with effective governors, which must be properly maintained: the speed of the tool should be regularly checked.
- Grinders must be fitted with protective guards.
- Grinders must be clearly marked with their maximum rotating speed.
- Abrasive wheels larger than 55mm diameter must be marked with their max running speed
- The proper size and type of wheel or disc must be fitted to suit the tool in use.
- Eye protection must be worn.
- Persons fitting wheels or discs must be competent and properly trained.

Tampers

Tampers should always be used with both hands on the tool and feet spaced apart. Foot injuries can be serious with this item of equipment. Held firmly, it is not only controlled better, but produces more useful work; Safety boots must always be worn.

Wood Borers (Drills)

It is essential that the machine is picked up only by the handles, is firmly held against the job, all clothing being kept out of the way, and is only extracted and put down once the drill has stopped revolving.

11. CARTRIDGE OPERATED TOOLS

Cartridge-powered tools have the advantage of portability. However in the wrong hands, they can maim, if not kill and their effect is not necessarily confined to the firing area. In trained and competent hands, these tools are safe. They can accomplish thoroughly satisfactory fixings in most forms of concrete,

brick and steel, although it is always advisable to carry out tests, especially in concrete and masonry, before the method is put into general practice on site.

It is essential; therefore, that these tools are used only by properly trained and certified operators because cartridges are identified by color, operators must not suffer from defective color vision. Management must ensure that all cartridge tool operators are thoroughly trained.

Types

There are two main types of cartridge tool:

Direct Action (high velocity)

Direct action is where the explosion from the cartridge fires the fastener down the barrel and into the work.

Direct acting tools produce a muzzle velocity at least comparable with small firearms and therefore should be handled with the same degree of respect afforded to a gun. Injury can be caused up to 500m away. Tests have shown that fasteners from this type of tool completely penetrated two 50mm blocks of wood and embedded themselves into a third 50mm block.

These tools must not be used on construction sites.

Indirect Acting (low velocity)

Indirect Acting is where the explosion from the cartridge acts on a piston which in turn drives the fastener into the work.

Indirect acting tools have about a quarter of the muzzle velocity, but are still sufficiently powerful to cause serious injury. Similar tests showed that with this type of tool, fasteners were embedded in the first 50mm wooden block only.

With Indirect Acting tools, there are three ways in which the driving action can be achieved:

- The fastener and piston are in contact at the cartridge end of the tool and travel down the barrel together.
- The fastener is at the work face and the piston travels down the barrel to strike it.
- The fastener and piston are in contact with the work face, the piston also being in contact with the cartridge.

Fixing Devices

Each manufacturer produces a range of fixing devices designed for use in their own equipment. They should not be used in any other manufacturer's equipment.

Cartridges

Although the dimension and color may be similar, the strength of the charge, the force required to detonate it, and the exact fit of the cartridge in the chamber, are determined by each manufacturer. Cartridges, therefore, should be used only as specified by each individual manufacturer. They are not interchangeable.

Some cartridge tools have a power grading facility. This means that where previously, three or four different strengths of cartridge had to be stocked, now just one strength grade is necessary, the variance in power being controlled by the regulator on the tool itself.

Major Hazards

Apart from malevolent firing as a deliberate act, the major hazards are:

- Where material is of a soft nature, the fastener can puncture it and emerge from the other side like a bullet. This hazard is reduced, however, with Indirect Acting tools since, when the piston and nail separate, 90% of the cartridge energy remains with the piston and is dissipated within the tool.
- Where the material is brittle or of an uneven constituency, the fixing device may turn back on itself ("ricochet") and injure the operator.
- The material may splinter at the point of impact.
- Recoil, which may throw the operator off balance.
- Excessive noise level in certain circumstances e.g. in confined spaces.

Precautions

- Operators must wear head, eye and ear protection when using cartridge operated tools.
- Guards of sufficient size to check flying pins and splinters are always fitted on the more powerful tools. They are made so that their removal puts the equipment out of action. Where cut-away guards are provided for work in particularly difficult circumstances, extra precautions must be taken against flying fasteners and splinters. It must be ensured that operators appreciate the additional danger, both to themselves and to others in the vicinity.
- Guards should always be firmly held flush to the surface, to prevent the escape of fasteners and splinters.
- Guards are often sprung so that the tool cannot be fired if it is at an angle of more than 7° to the work surface.
- This occurs most frequently when the operator tries to fire into a hole already made by an earlier fastener, which has failed to hold. With high-powered tools, the fastener can easily be deflected back towards the operator, and it is essential that any new fixing should be at least 50mm away from any existing hole. With low powered tools, the pin will most probably bend and become wedged in the end of the barrel.


- Cartridge tools should not be used on brittle materials (such as grey cast iron), or glazed materials, which are likely to splinter on impact. It should be noted that the severity of the splintering varies according to the power of the tool.
- Noise level varies with the type and manufacturer, but if cartridge tools are to be used in confined areas, ear protection must always be worn as a precaution.
- Recoil from firing can throw a man off balance: therefore these tools must not be used from a ladder. If working at height. It is strongly recommended that tests should be made at ground level under identical circumstances to the work itself, so that the operator can become familiar with the force of the recoil.
- High-powered tools require the muzzle to be pressed hard against the work face before the equipment can be triggered, as a protection against accidental firing into the open air. It is strongly recommended that only those types which require two-handed operation should be used - i.e. one hand for pressure against the work face and triggering and the other hand for releasing the safety catch. This arrangement compels the operator to keep both hands clear of the muzzle.
- Should a misfire occur, the firing mechanism should be re-triggered without withdrawing the equipment from the work face, and the tool fired again. If it still fails to fire, it should be removed from the work face after a delay of 30 seconds. The operator should remove the cartridge in accordance with the manufacturer's instructions and return it to the supplier (properly stored in a metal box), for destruction by the manufacturer.
- Cartridge operated tools must not be taken into or used in situations where there is a risk of fire or explosion.
- All cartridge-operated tools should be thoroughly cleaned and lubricated after each usage, and returned to manufacturer for overhaul at least once per year.
- All cartridges should be kept under lock and key in a cool, dry place. The issue of cartridges must be carefully controlled.

SAFETY CHECKLIST

DO	ensure that the tool is in good	DO NOT use a suspect tool repair
DO	ensure that you know the misfire procedure: 1. hold the tool against the work surface for 30 seconds; 2. pull the trigger again; 3. if the cartridge still does not fire, wait another 30secs 4. Eject the cartridge (strictly in accordance with manufacturer's instructions) and return it to store for destruction by the manufacturer.	DO NOT load a cartridge before you need it.
DO	ensure that the tool is at right angles to the fixing surface.	DO NOT point the tool at any person
DO	use the correct fixing / piston cartridge combination	DO NOT fix less than 75mm from the edge of concrete or brick.
DO	change pistons when they are worn	DO NOT fix less than two and a half times the fastener's shank diameter from the edge of steel,
DO	change stop rings when they damaged	DO NOT fix to a spalled (uneven) surface or are existing hole
DO	wear the safety goggles provided	DO NOT fix where another fixing has failed
DO	ensure that the tool is cleaned and lubricated after use	DO NOT strip down the tool without checking
DO	keep cartridges not being used in the tool box or container.	DO NOT press a tool against your hand
DO	use ear protection, especially when fixing to steel, or working in a confined area.	DO NOT leave live cartridges lying about the job site
		DO NOT insert a cartridge until after the nail or stud is loaded.
		DO NOT attempt to use nails, studs or cartridges that have not been approved by the manufacturer.

12. ELECTRICALLY OPERATED TOOLS

12.1 General precautions

- All electrically operated tools should be used, where possible, on the reduced voltage of 110V to avoid the risk of a lethal shock. Additional protection is provided by the use of circulating current earth monitoring or earth leakage circuit breakers. All electrical tools should be to the Korean or international standards.
- A check should be made to see that the supply voltage is within the operating range as marked on the tool plate.
- All plugs and sockets should conform to the Korean or international standard, so that they cannot be plugged into the wrong supply.
- All electrical tools must be either grounded or "double insulated". The latter is recommended and is indicated by the symbol .
- It is important to note that, if a transformer is used, it should be center tapped to ground. Transformers are rated in Watts (W) and care should be taken to ensure they are not overloaded, causing either the transformer fuses to blow, or the internal windings to melt.
- Chuck keys should be kept on a clip attached to the cable to avoid any temptation to improvise.
- Whenever on the spot adjustments or changes in attachments need to be made, tools must be disconnected from the supply. (Use of the control switch on the handle is insufficient. The plug should remain with the operator while repairs or adjustments are carried out).
- All attachments should be firmly fixed - loose saw blades, etc. can cause serious damage.
- Guards are frequently incorporated, both in compliance with statutory requirements and because they have been specially designed to promote maximum safety in operation. Every precaution must be taken to see that these guards are not interfered with in any way.
- Goggles, helmets, dust masks, ear protectors, etc. must be worn as necessary when electrical tools are in use.

12.2 Inspection and Maintenance

- All electrical tools should be carefully inspected before and after use for signs of faults in wiring, switching, guards, etc. Any defects should be immediately reported.
- A competent mechanic or electrician, on a regular basis should carry out, maintenance. A register should be kept of all such maintenance.

12.3 Individual Tools

Powered, hand-held saws

Such saws are fitted with spring loaded guards which only uncover the saw teeth when the tool is pressed against the work. A check should be made regularly to ensure that the guard is moving freely.

To prevent damage to hands, the saw teeth above the sole plate are enclosed in a permanent guard.

The work should be clamped and both hands used to control the saw. On larger, portable stand models, a riving knife is fitted to prevent the cut from binding on the saw teeth and to prevent the material from binding at the back of the saw blade and kicking back. The riving knife should therefore be kept clean and comparatively sharp.

The work area should be kept clear of all potential tripping hazards.

Drills

The common operating fault lies in trying to drill too large a hole at once: as the bit breaks through the last piece of material it binds and stops the motor. The torque set up twists the tool against the user's wrist and can easily cause a bad sprain. Where necessary pilot holes should be drilled.

All material to be drilled should be firmly secured so that it cannot spin as the drill begins to bite.

Rotary hammer drills should be fitted with a safety clutch to protect both operator and tool should the drill bit snag.

All drill bits should be kept sharp and a punch mark should be made as a starter.

Drills, once switched off, should be held until they have ceased turning before being set down.

Grinders

The guidance given under Air grinders on page 18 applies equally to electrically operated tools (apart from the item referring to governors). Further advice is given under Petrol engine driven grinders.

Chain Saws

Chain saw accidents are rarely trivial. The tool can kill and is more than capable of severing an arm or leg. It is essential therefore; operators are properly trained and supervised.

Before use, a check should be made that:

- Guards are in position and in good repair
- The chain, guide bar and sprocket are undamaged
- All external fittings are secure
- The chain is sharp and the tension is in accordance with the manufacturer's instructions
- The lubrication system is working.
- In use, it is essential to have a secure foothold and to hold the saw firmly, with both hands.
- Protective clothing safety helmet, ear defenders, eye protection, close fitting clothing, gloves and chain saw
- Operators boot (high leg) - must be worn.

12.4 Electrical Tool Safety Check list

Before Use

1. Check for relevant Standards and Double Insulation marks.
2. Check details on tool plate, which should include:

Type	Serial No.
Voltage	Volts AC/DC
Frequency	(Normally 50HZ, 60HZ in Korea)
Current	Amps
Speed	RPM

 - Check that the tool is fitted with the correct plug and inserted into the proper receptacle.
 - Check that the lead is not cut or frayed and that it is effectively clamped at entry to the tool and plug.
 - Check that there are no cracks or pieces missing from the tool casing.
 - Check that all screws are in place and secure.
 - Check the permissible number of power tools on each circuit or transformer is not exceeded.
 - Check that any extension lead is suitably rated for the electrical current.

During Use

- DO disconnect the tool before adjusting or working on it.
- DO disconnect the tool when not in use.
- DO report any defects immediately.
- DO keep the tool clean and free from damp.
- DO wear appropriate protective equipment - goggles, ear muffs, helmet, safety boots, etc.
- DO always hold the side-handle, where applicable.
- DO NOT carry the tool by its cable.
- DO NOT use any "makeshift cable.
- DO NOT try to repair a defective tool - report it.
- DO NOT start or stop tools when under load.

13. GASOLINE ENGINED TOOLS Fuelling

Containers should be in good condition, leak proof and have secure caps. Safety cans must be used for handling the gasoline in quantities greater than 4 liters. For quantities of 4 liters or less, only metal containers shall be used..

Fuel caps should be securely replaced and any spillage wiped off after filling. No fires or smoking should be allowed within 20m of the fuelling or fuel storage area and tools must not be started within 10m of the area.

13.1 Exhaust Gases

Gasoline engine tools give off toxic fumes and must never be used in confined areas, such as buildings, unless there is adequate ventilation.

13.2 Noise

Most gasoline engine tools operate at noise levels above 85 dB, so hearing protection must be worn.

13.3 Individual Tools

Abrasive wheel cutting-off machines and chain saws are the most commonly used gasoline engine tools. The guidance given previously should be observed. In addition operators should be familiar with the following procedures:

13.4 Cut-off Machines

Before Starting

1. Ensure that other persons are kept at a safe distance; in particular that no one stands directly in front of the machine.
2. Ensure that the correct cutting-off wheel is fitted, undamaged and it spins freely.
3. Check the wheel guard for cracks and that the drive belt is properly tensioned.

Starting

Pull out the choke (if starting from cold). Lock the throttle safety catch. Place one foot on the rear handle and one hand on the front handle. Pull the starting cord and release when fully withdrawn.

After Starting

Push in the choke (if starting from cold). Open the throttle wide to release the safety catch. Allow the engine to warm up before starting work.

13.5 Work Posture

Always work with a straight back and knees bent. Brace the engine against the leg, keeping the body above the cut-off wheel in order to obtain optimum control of the machine.

13.6 Application of the Wheel

Before starting to cut, ensure that the wheel is revolving at top speed.

13.7 Cutting Steel

Cutting steel always generates sparks. Ensure that a fire-extinguisher or a bucket of water is readily available.

13.8 Cutting Concrete

Concrete cutting produces large amounts of dust. The work must either be watered down or dust masks worn.

Ensure that the cutter is not held at an angle, which can cause it to break.

13.9 Chain Saws

Before Starting

Check that the stops switch is clearly marked and functioning, check that the chain brake (if fitted) works properly.

Ensure that other persons are kept at a safe distance. Check that the working area is clear of obstructions.

Starting

Place the saw on level ground, put one foot on the rear handle base plate and one hand on the front handle.

If starting from cold, engage half throttle and pull out the choke. Switch on and pull the starter cord firmly.

After Starting

Check that the chain runs freely and stops when the throttle control is released, the on/off switch is working and that the chain brake (if fitted) is effective.

Stopping

Close the throttle to stop the saw and ensure that the brake is engaged before putting the saw down. Clean and grease the saw before storing in the proper container.

Records of calibration check and adjustment shall be maintained by the HSE office.

14. WOODWORKING MACHINERY

14.1 What should you do before using woodworking machines?

Woodworking tools can be dangerous if not used properly.

Only use woodworking machines that you have been trained to use properly and safely.

Read the owner's manual carefully.

Make sure you understand instructions before attempting to use any tool or machine. Ask questions if you have any doubts about doing the work safely.

14.2 What safety procedures should you follow when using woodworking machines?

Always wear safety glasses or goggles

Wear dust masks when required.

Wear hearing protection that is suitable for the level and frequency of the noise you are exposed to in the woodworking area. If you have trouble hearing someone speak from three feet away, the noise level from the machine is too high. Damage to hearing may occur.

Use gloves to protect hands from splinters when handling wood but do not wear them near rotating blades and other machinery parts where the gloves can catch.

Make sure the guard is in position, is in good working condition, and guards the machine adequately before operating any equipment or machine. Check and adjust all other safety devices.

Make sure the equipment is properly grounded before use.

Check that keys and adjusting wrenches are removed from the machine before turning on the power.

Inspect stock for nails or other materials before cutting, planning, routing or carrying out similar activities.

Make sure that all machines have start and stop buttons within easy and convenient reach of an operator. Start buttons should be protected so that accidental contact will not start the machine. A collar around the button 3 to 6 mm above the button is recommended.

Ensure that all cutting tools and blades are clean, sharp, and in good working order so that they will cut freely, not forced.

Turn the power off and unplug the power cord (or lock out the power source) before inspecting, changing, cleaning, adjusting or repairing a blade or a machine. Also turn the power off when discussing the work.

Use a "push stick" to push material into the cutting area. Jigs are also useful in keeping hands safe during cutting procedures. Keep hands out of the line of the cutting blade.

Clamp down and secure all work pieces when drilling or milling.

Use good lighting so that the work piece, cutting blades, and machine controls can be seen clearly. Position or shade lighting sources so they do not shine in the operator's eyes or cause any glare and reflections.

Ensure that the floor space around the equipment is sufficient to enable you to machine the size of work piece being processed safely without bumping into other workers or equipment.

Woodworking machines should be fitted with efficient and well-maintained local exhaust ventilation systems to remove sawdust or chips that are produced.

Electric power cords should be above head level or in the floor in such a way that they are not tripping hazards.

Keep work area free of clutter, clean, well swept, and well lit. Spills should be cleaned up immediately. Floor areas should be level and non-slip. Good housekeeping practices and workplace design will reduce the number of injuries and accidents from slips, trips, and falls.

14.3 What should you avoid when working with woodworking machines?

Do not wear loose clothing, work gloves, neckties, rings, bracelets or other jewelry that can become entangled with moving parts.

Avoid awkward operations and hand positions where a sudden slip could cause your hand to move into the cutting tool or blade.

Do not remove sawdust or cuttings from the cutting head by hand while a machine is running. Use a stick or brush when the machine has stopped moving.

Do not use compressed air to remove sawdust, turnings, etc. from machines or clothing.

Do not leave machines running unattended (unless they are designed and intended to be operated while unattended). Do not leave a machine until the power off is turned off and the machine come to a complete stop.

Do not try to free a stalled blade before turning the power off.

Do not distract or startle an operator while he or she is using woodworking equipment.

Horse play should be prohibited. It can lead to injuries.