Chapter 17

Use explosive power tools

LEARNING OBJECTIVES

This chapter details the information and performance required to apply safe and effective operation of explosive power tools (EPT), also known as powder-actuated (PA) fastening tools, which are used to fasten materials or fix fasteners to predominately concrete or steel bases.

WHS requirements

As of 2010, WorkCover no longer requires the operator of a PA tool to hold an operator's certificate of competency. However, before a PA tool can be used, there are a number of requirements that need to be met.

The employer or, as they are currently referred to in the WHS Act, the person conducting a business or undertaking (PCBU) has a responsibility to make an assessment of the operator's competency. WorkCover defines a competent person as: 'a person who has acquired through training, qualifications or experience, or a combination of them, the knowledge and skills to carry out that task'. This requirement could be met by sighting qualifications, acknowledgement of prior experience or by direct observation of the person undertaking tasks.

Under the WHS Act, the PCBU has a duty to provide a safe working environment, which includes safe plant and equipment, as well as safe systems of work. For these obligations to be met, a risk assessment in the form of a Job Safety Analysis (JSA) or a Safe Work Method Statement (SWMS) is required (see Appendix 1).

The current regulation governing the use of PA tools is 'AS/NZS 1873: 2003 Powder-actuated (PA) hand fastening tools'. This standard is divided into four parts:

- Part 1: Selection, operation and maintenance
- Part 2: Design and construction
- Part 3: Charges
- Part 4: Fasteners

Personal protective equipment

After a risk assessment has been undertaken by the PCBU or controller of the site, the WHS Act requires that any hazards found are controlled. These controls should be implemented using one or more of the controls shown in Figure 17.1.

Most of the hazards encountered when using a PA tool can be managed using the first four controls, with the exception of those that affect the eyes and hearing of the operator and people in the immediate area. As these cannot be managed by any other means, the use of personal protective equipment (PPE) is the most appropriate control.

The chance of debris or even the fastener hitting someone in the eye is quite high and can be controlled with the correct eye protection. Although not long in duration, the noise hazard does tend to spike quite high and will cause hearing damage with prolonged exposure. The most appropriate control for this hazard is the use of adequate hearing protection.

It is important to remember that the operator as well as any other persons working in the immediate area should always wear suitable eye and ear protection.

Tool selection

There are a number of different tools available for various fastening and fixing applications. Care should be taken to select the most appropriate tool for the task. There are a number of alternative gas-impulse and compressed-air driven fixing tools suitable for firing into both concrete and steel; however, in most cases they are only suitable for lighter duty applications.

Powder-actuated tools fall into two categories:

- Direct-acting, high-velocity tools
- Indirect acting, low-velocity tools.

Direct-acting

The energy of the charge in direct-acting tools is transferred directly to the fastener.

Because of the high velocity of this tool (up to 600 m/s), there is a high risk of through shot and free flight. This occurs when the fastener passes through the base material and continues travelling until it hits something dense enough to

Fig. 17.1 Control measures for hazards

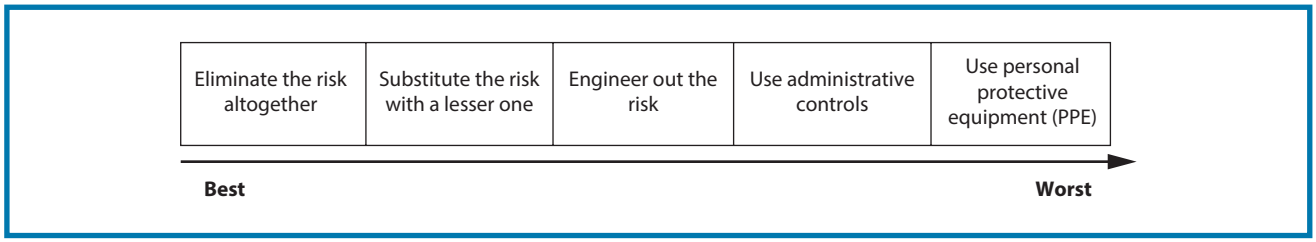


Fig. 17.2 Charge acts directly on fastener

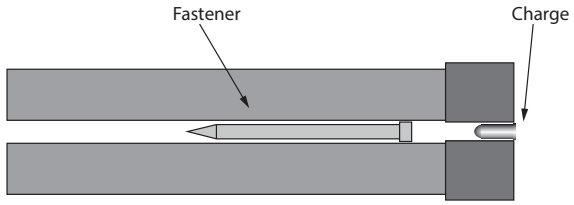


Fig. 17.3 Direct-acting power tool

stop it. In most situations this is a wall or floor in the adjoining room, but sometimes it may be a person in the next room!

The free flight caused by deflection off the base material is also of considerable danger to anyone in the immediate area as well as people in the adjacent areas. Care should be taken that no one is down range of the operator, including behind the wall and above or below slabs being fired into.

This tool can also pose a threat to the operator as it may bounce off a surface and come back at them.

Explosive power tool fastener kills worker

This alert follows from an incident in which a worker was killed when a fastener (nail), fired by him from a high-velocity Powder-Actuated Tool (PAT), ricocheted and pierced his heart. It warns employers and users of PATs of the danger and the risks to operators and other persons when these tools are used and provides advice to control such risks.

***WorkSafe Victoria Alert*, 2 July 2007**

Although it is still currently legal to use this type of tool, most commercial sites prohibit the use of direct-acting tools. Additionally, the two major manufacturers of these tools no longer provide service for these tools. As there is a requirement to have the tool serviced by an authorised service person every 12 months, this will become increasingly more difficult.

Indirect-acting tools

An indirect-acting tool is one where the charge energy is expelled onto a captive piston that delivers a hammer blow to the fastener.

Fig. 17.4 Charge acts on drive pin

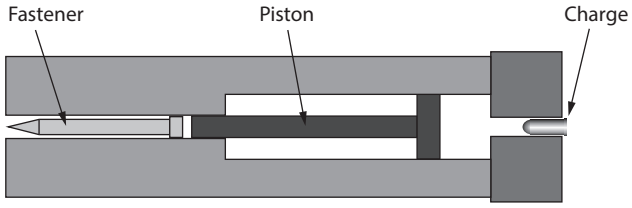


Fig. 17.5 Indirect-acting power tool

This tool operates at lower velocity (up to 100 m/s) and as a result considerably reduces the chances of free flight. It also differs from the direct-acting tool as it does not require a large muzzle guard as most of the gases are not released from the end of the barrel. The chance of ricochet is also considerably reduced. This type of tool will supersede the direct-acting tool in the coming years.

Some models of this type of tool also provide the benefit of multi-fire capability. When fitted with a magazine to accommodate collated nails and strip charges, a number of fixings can be made quickly.

Suitable materials for fixing

Not all materials are suitable for this type of fixing. For example, materials that are too soft, too hard or brittle should be avoided.

Unsuitable materials

You should not drive fasteners into:

- brittle or hard materials such as marble, glass, glazed tiles, cast iron, fired clay bricks or concrete with a compressive strength greater 60 MPa
- heat-affected steel, as welding and flame cutting can cause the steel to harden
- timber as the base material, including plywood, particle board and hardboard (this type of fixing is not suitable for timber to timber attachment)
- mortar joints in brickwork or stonework
- soft materials such as plasterboard, aerated concrete and low strength concrete ($\leq$10 MPa).

Concrete

Because of the risk of cracking and disintegration, the following minimum distances should be adhered to. Thus, fasteners should not be used:

- more than 75 mm from the edge
- less than 75 mm from another fastener
- in concrete less than 100 mm thick
- within 150 mm from where another fastener has damaged the surrounding material.

Steel

Fasteners should not be driven into steel:

- less than 13 mm from the edge
- less than 25 mm from another fastener
- less than 100 mm from heat-affected thick concrete
- less than 4 mm thick or 3 mm if specialised fasteners are being used.

Suitable with care

Care should be exercised when using PA tools when firing into concrete-containing large-section aggregate. Caution should be also shown when using PA tools to fix fasteners into prestressed and post-tensioned type structures. Advice as to the suitability of use should be sought from the designer.

Never use a PA tool:

- in the presence of any explosive or flammable gas, dust or vapour
- in a compressed atmosphere such as a pressurised vessel
- where the charge may be made dangerous by the presence of excessive heat (i.e. temperatures above 50°C).

Test for suitability

Use a hammer to drive a fastener into the base material to see what the effect is on both the fastener and the base material.

- **If the point of the fastener is damaged then the material is too hard for fixing using PA tool.**
- **If the base material shows any sign of cracking, it is too brittle for fixing.**
- **If the fastener is driven easily into the material, it is too soft for fixing.**
- **If the fastener makes a clear impression of the point of the fastener and is not blunted, then a trial fixing can be made.**

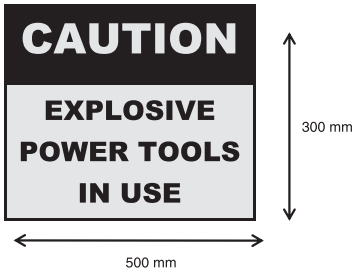
Worksite safety

Before any work is carried out on a worksite, a JSA should be provided by the PCBU to the employees. (A sample JSA is shown in Appendix 1.) Alternatively, in the case of a subcontractor, a SWMS should be given to the controller of the site.

The immediate area surrounding where the fixing is being carried out should be secured to stop other workers or the public walking into the line of fire. An exclusion zone of 6 metres should be maintained. This can be achieved at a minimum by the use of signage at access points; better still would be to have someone watching out at entrances.

When PA tools are being used a sign must be displayed that these tools are in use. It should be displayed in a prominent position. The sign should be no smaller than dimensions stated below.

Fig. 17.6 Signage requirements



The following steps should be taken to ensure worksite safety:

1. Clear the immediate area of anyone that does not need to be there.
2. Put up warning signs at all entrances.
3. Make sure the area is safe for the use of PA tools (no inflammable gases and explosive materials).
4. Check base materials suitability for use with PA tools using fastener as a punch.
5. Operator and anyone else in the immediate area should be wearing correct PPE.
6. Check tool is ready for use.

Charges

Explosive charges, also known as power loads, provide the driving force required to propel the fastener into the base material. There are a number of different types of charges available for use in PA tools. These range from single shot for direct-acting tools to multi-fire strips or discs for indirect-acting tools. Only use charges that are specified by the manufacturer for use in the tool being used.

The strength of the charges is identified by a colour code as shown in Table 17.1.

Fig. 17.7 Charges

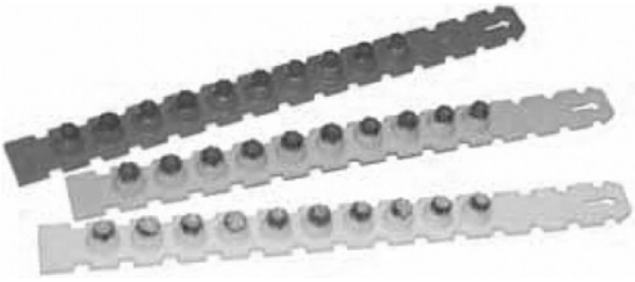


Table 17.1 Colour indentification of charge

Relative strength	*Identification colour*
Minimum	Grey
Very weak	Brown
Weak	Green
Medium	Yellow
Medium strong	Blue
Strong	Red
Very strong	Purple
Especially strong	White
Maximum	Black

All of the charges referred to are not generally available for indirect action tools. The main colours currently available are green, yellow and red. Black is available for specific tools made by Hilti and purple for some tools made by Ramset.

In some previous texts the issue of colour blindness and the ability of a person to operate a PA tool has been promoted. The only requirement to use PA tools is that the operator can distinguish between the different coloured charges. As most people with colour blindness do see colour, not just black and white, a simple test can be made by asking the operator to name the different colours. This should be enough to assess their competence in regard to colour vision.

Fasteners

The selection of the correct fastener depends on the material the fixture is being fastened to and the thickness of the fixture. It is unsafe to use any other fasteners than those that are recommended for use in a particular tool.

Attaching fixtures to steel

To achieve maximum holding power, ensure that the fastener or threaded stud fully penetrates the steel base material. This is especially important when fixings are resisting a pull-out type load.

For fixing to steel:

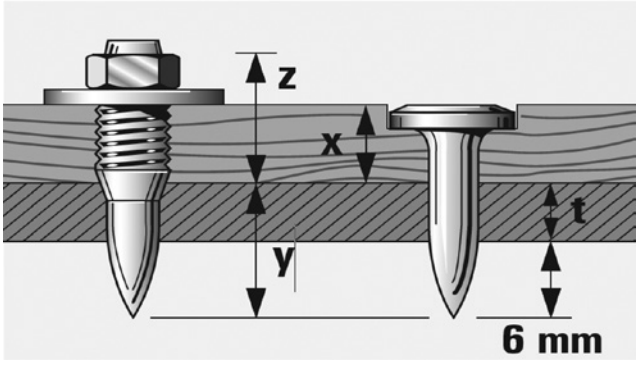
- for thicknesses of 4 mm to 8 mm, the required length of the fastener can be calculated by adding the fixture thickness to the thickness of the steel and then adding 6 mm to ensure there is full penetration
- if steel is over 8 mm, the required length of fastener is calculated by adding 12 mm to the thickness of the fixture.

In the example shown in Figure 17.8, assuming:

- fixture of thickness (X) = 19 mm
- steel thickness (t) = 5 mm
- allowance for penetration = 6 mm
- drive pin length = 30 mm

An additional allowance should be made for thread of the stud (Z in Figure 17.8) to be clear of the surface of the fixture.

Fig. 17.8 Fastening to steel



Threaded studs are best used when additional fixtures will be attached to the surface and need to be removable. The length of the thread is an important consideration as well as the length of the stud.

Attaching fixtures to concrete

When the base material is concrete, it is essential that the fastener is embedded deep enough to provide a secure fix. To calculate the depth of embedment, multiply the diameter of the shank of the pin or stud by a factor of six to eight times. If the shank is 3.8 mm, this would mean an embedment of 22 mm to 30 mm.

The guide for fixing to concrete is: fixture thickness + 25 mm.

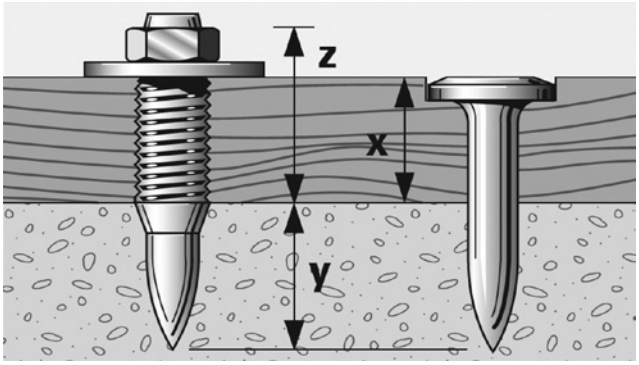
In the example shown in Figure 17.9, assuming:

- fixture of thickness (X) = 45 mm
- allowance for penetration (y) = 25 mm
- drive pin length = 70 mm

Pin selection and correct setting

To achieve secure fixing, a combination of both the correct length of fastener and appropriate power load for the base material needs to be calculated.

Fig. 17.9 Fastening to concrete

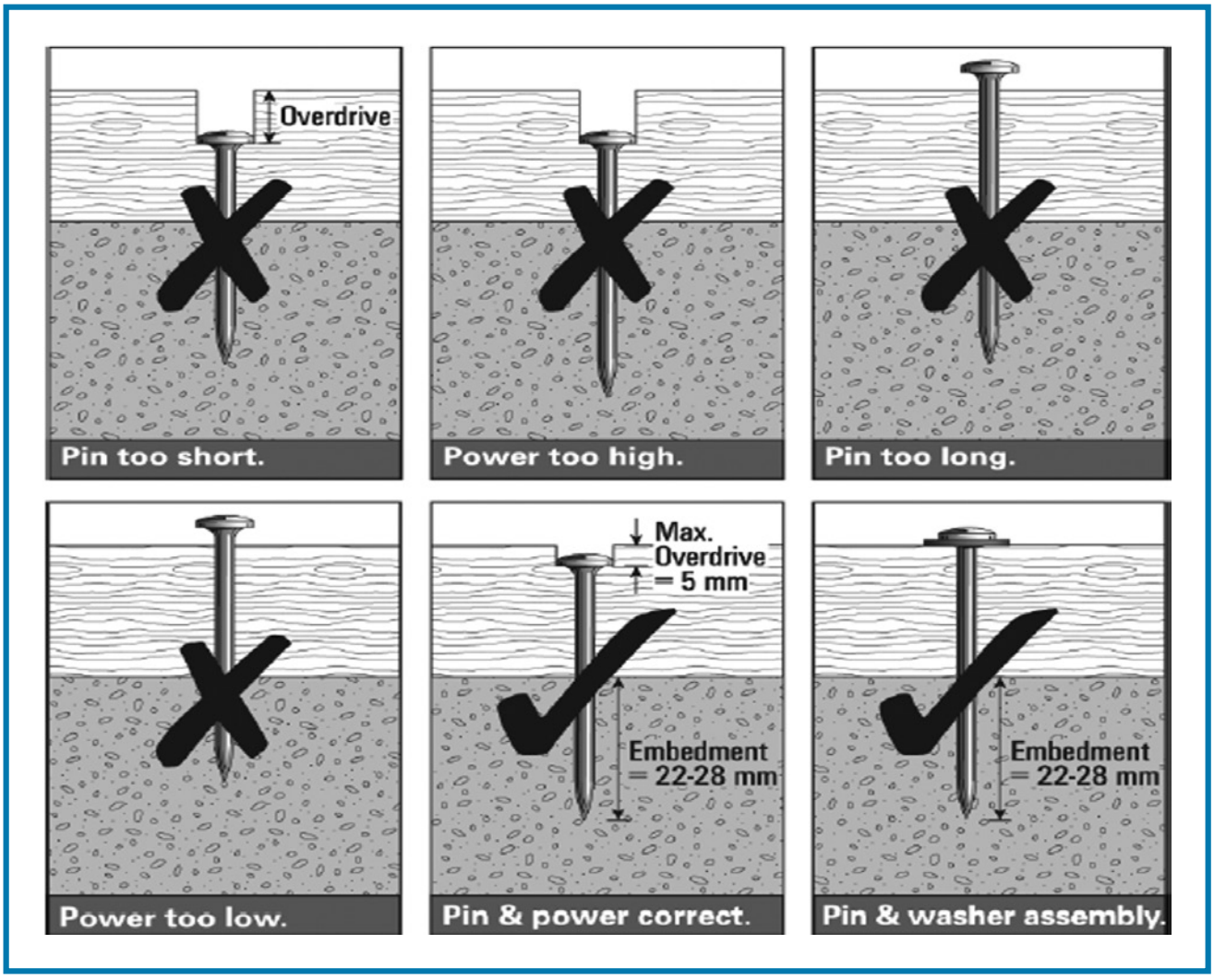


If the fastener is too long or the power load is not strong enough, the fastener will stick out of the top of the fixture. Alternately, if the fastener is too short or the power load too strong, the pin will be driven too far into the fixture.

An embedment of 22 mm to 28 mm should be calculated and achieved by varying the power load and power adjustment on the tool. Some trial and error at this stage is required.

Note: Always start with the lowest power load that you think will do the job and work your way up if necessary.

Fig. 17.10 Correct setting of fastener



Operating procedures

Standard operating procedure for a direct tool

Fig. 17.11A 1. Open tool and insert the fastener into the barrel of the tool.

Fig. 17.11B 2. If required, use a rod to push the fastener down the barrel. The further it is pushed down, the more room for the expansion of gases and, as a result, less power delivered to the fastener. Use this method for controlling power setting between power loads.

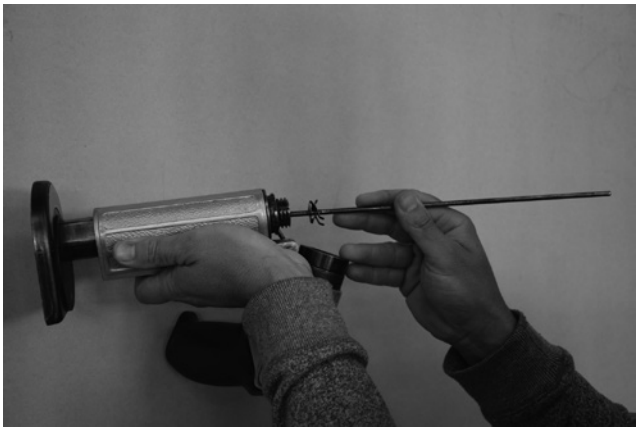


Fig. 17.11C 3. Insert selected power load into breach plug.

Fig. 17.11D 4. Insert plug and charge into barrel of the tool. Close and lock with a twisting action.

Fig. 17.11E 5. Hold the tool using both hands and position tool square to the surface of the material being fastened. The tool is designed not to fire if it is greater than six degrees perpendicular to the surface. Push the tool firmly against the surface and call "Firing" *before* pressing the trigger.

Standard operating procedure for an indirect tool

Below is the standard operating procedure for the Ramset FrameBoss Power Actuated Tool.

Fig. 17.12A Step 1: Cycle the tool

1. Open the tool by holding the barrel and sliding it firmly forward until it reaches the stop point, and then close it by pushing the barrel back until it closes.

Fig. 17.12B Step 2: Insert the power load

2. With the tool in the closed position, insert a power load strip into the cavity in the base of the rubber handle and push it in until the flat of your fingertip is firmly against the handle recess. The first power load is now aligned with the chamber prior to cocking.

Note: Always use the lowest strength power load and power setting first for a firing test. Then adjust the power to suit the job.

Fig. 17.12C Step 3: Select and insert the fastener

3. Select the correct fastener for the application. Point the tool down and away from yourself and any other person. Insert a fastener HEAD FIRST into the fastener guide at the front end of the tool, making sure the fastener guide stays in the forward position.

Fig. 17.12D Take up the correct firing stance

4. Make sure the tool is at right angles (90°) in both directions to the work surface. Your body should be directly behind the tool in a balanced posture.

Fig. 17.12E Step 5: Fire the tool

5. Press the fastener guide firmly against the work surface and call 'FIRING' to alert those nearby and then pull the trigger.
6. **Check the fastener has been correctly set**.

Fig. 17.12F Step 7: Adjust the power, if necessary

7. Increase power by increasing power setting. When the maximum setting is reached, move the wheel back to minimum position and insert next strength power load.
8. **Repeat steps 1–7 for the next fixing point**.

Misfires

In the event of a misfire, observe the manufacturer's misfire precautions and procedures.

The following is the procedure given in Ramset's FrameBoss instruction manual:

1. In the event of a misfire, continue to hold the tool against the work surface for a minimum of 10 seconds.
2. After this time release the tool from the work surface but continue to point the fastener guide towards the work surface.
3. Remove the power load or power load strip as per normal operation.
   (a) If the power load strip can be removed normally without any unusual effort or force, return the power load or entire power load strip to supplier/Ramset in a safe manner.
   (b) If the power load cannot be extracted from the tool in the usual manner, return the entire tool and power load/s in an enclosed metal container.
   (c) If a tool misfires repeatedly over consecutive power load strips, then the tool should be returned for service with the power load strip immediately.

Some older resources suggest that misfired charges be placed in a bucket of water. This is not a requirement stated in the standard or by the manufacturers. This supposes that if the charge does not fire within 10 seconds, the charge can be deemed to be safe and returned in the manner stated above.

Tool jams

In the event that a tool becomes jammed the following steps should be taken:

- If the power load that is in line with the barrel has been detonated, you can attempt to release the drive pin. The manufacturer's maintenance information will detail how this can be done. Do not use excessive force.
- If the tool jam cannot be cleared, the tool should be returned to the manufacturer for servicing.
- If the power load that is in line with the barrel has **NOT** been detonated, then it is important that no attempt be made to cycle the tool. This is an extremely dangerous situation as the tool could detonate at any time. Keep the tool pointed down and away from all people. Do not place hands over the barrel of the tool. The entire tool and jammed power load should be carefully placed in its metal case and returned to the supplier.

Do not send the tool by post or courier. If you cannot transport it to the service centre yourself, contact supplier for suggestions on how it can be delivered for repair.

Adaptors and specialised accessories

Manufacturers of PA tools provide many adaptors to do various tasks. These adapters should only be used on the tools they are designed for. These adapters can be broadly grouped into the following categories:

- **Spall guards**: These guards are fitted to provide some protection to the operator against debris being thrown back at the operator.
- **Barrel extensions**: These are used when the barrel cannot make good perpendicular contact with the material being fastened. An example of this would be corrugated surface or metal extrusions.
- **Magazine adaptors**: These are fitted to enable the use of multi-shot function using collated drive pins.

Fig. 17.13 Magazine adaptor

- **Fastener guides**: These are used to align the drive pin with accessories, washers, hanging brackets and pre-drilled holes.
- **Extension attachments**: Available for installation of fasteners and brackets to the underside of concrete slabs, they enable the fastening to occur without the use of ladders. This type of tool should not be used on walls or floors.

Fig. 17.14 PA tool for overhead use

Fig. 17.15 Extension attachment

Nail removal

Drive pins are manufactured using high tensile steel, which means they can shatter if excessive force is used on them. Fasteners should not be struck with a hammer as they could cause fragments to be released at dangerously high velocities. Manufacturers produce pin-breaking tools for this purpose; however, any solid section of steel pipe with an internal diameter of about 10 mm would be suitable.

If a fastener needs to be removed, the following method is recommended:

- Always ensure that you and all people in the immediate area are wearing their eye protection.
- Place the breaking tool over the drive pin and bend back and forth until it breaks off.

Storage

When not in use the PA tool should be:

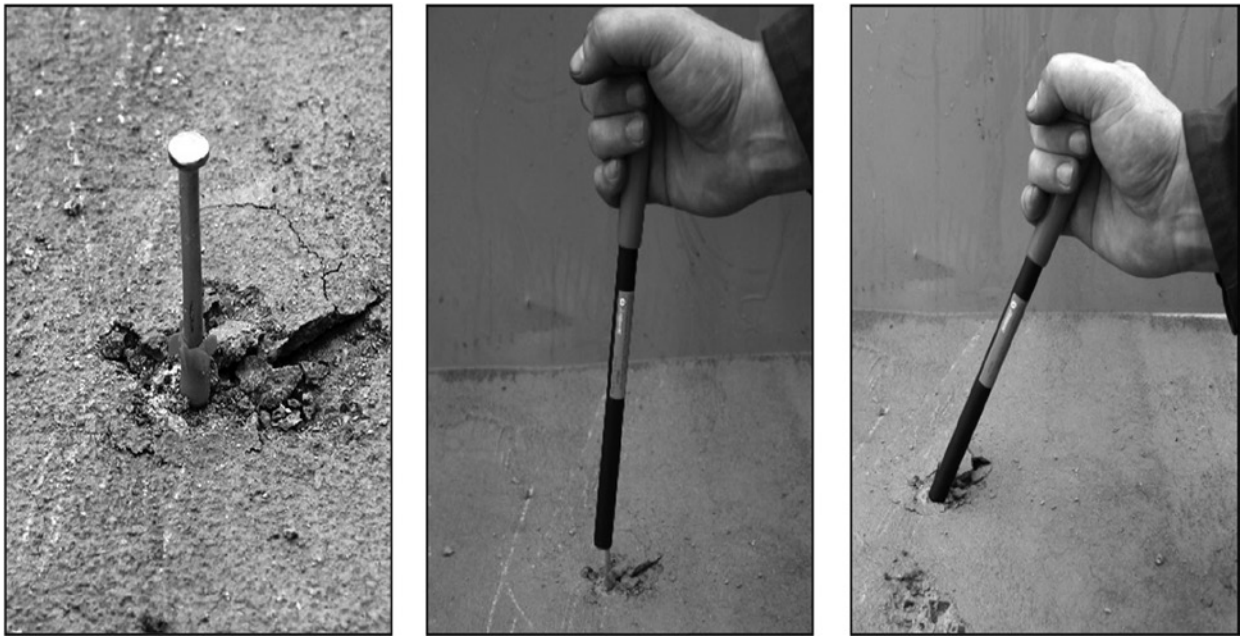
- unloaded and secured in a lockable case
- explosive charges are kept in separate lockable boxes labelled 'EXPLOSIVE CHARGES'
- stored in a secure place to prevent unauthorised use.

Fig. 17.17 PA storage

Maintenance

Prior to use, the PA tool should be inspected in accordance with the manufacturer's instructions to ensure it is fully operational and free from any defects that may affect its operation.

Fig. 17.16 Safe nail removal



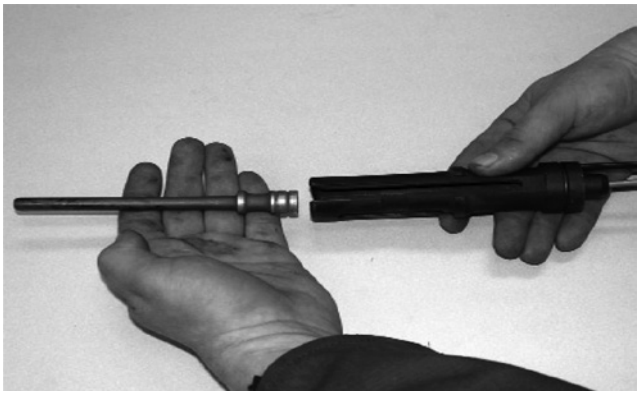
Operators should familiarise themselves with the manufacturer's maintenance schedule to ensure correct functioning of the PA tool.

As a minimum the tool should be:

- cleaned at least once a day after use
- dismantled and checked for defects once a week when the tool is in use.

If the tool is used by more than one person, the weekly checks should be entered into the logbook.

Fig. 17.18 Piston removed for cleaning



Repairs

Operators of PA tools should not attempt to repair their tools, other than the simple replacement of worn parts that are detailed in the supplier's manual. All other repairs need to be carried out by the manufacturer or their authorised agent.

After any major repair or overhaul is carried out, the person completing the work should provide the owner of the tool with a certificate indicating that the tool is free from defects. Details of the work carried out should be entered into the logbook, including what has been done, when and by whom.

The PA tool should be returned to the manufacturer or their authorised agent at a minimum of once every 12 months.

Fig. 17.19 Logbook with service details

Date	*Type of service*	*Hours used*	*Details of service (show components replaced)*	*Status*	*Signature*

Safe use summary

Table 17.2 Summary of safe use

Always	*Never*
Read the manufacturer's instruction manual	Use PA tools unless you have been trained
Follow the manufacturer's schedule for maintenance	Adapt or alter the tool or attachments
Secure the tool when not in use	Use PA tool near explosive or flammable gases
Display warning signs when in use	Load the tool until you are ready to fasten
Check barrel is clear before loading fasteners	Leave tool loaded when not in use
Operate with correct PPE (eyes and ears)	Point PA tool at any person, loaded or unloaded
Carry the tool pointing down and away from the operator	Fire into an existing hole unless the tool has been fitted with an alignment device
Maintain correct distances from edge of material	Fix timber to timber using PA tools
Check suitability of base material for fastening	Fire into brittle or very hard materials
Fire tools at 90 degrees to the base material	Fire tools at an angle to base material
Ensure the area behind base material is clear	Place your hand over the muzzle of the tool

Student research

Ramset Australia provides a training resource which may be viewed on YouTube at https://youtu.be/4V1SP9akV-s.

Worksheet: Using explosive power tools

1. What is the difference between a direct-acting tool and an indirect-acting tool?

2. Why should a PA tool not be fired at an angle other than 90° to the work surface?

3. Why should you never place your hand over the muzzle/fastener guide?

4. Where are explosive-powered tools and explosive charges kept when not in use?

5. What is the misfire procedure?

6. What should be done if the PA tool repeatedly misfires?

7. What must be done if the tool jams with a live charge in it?

8. What items of PPE should always be worn when using a PA tool?

9. How close to an external corner, hole or edge in the following materials is it permissible to fix a fastener?
   - (a) Steel:
   - (b) Masonry/concrete:

10. Name five base materials that should not be fastened into using a PA tool?
    - (a)
    - (b)
    - (c)
    - (d)
    - (e)

Appendix 1: Sample Job Safety Analysis

Workplace:		Statement prepared by: *Signature* …… *Date* ……../……../……..	
Work to be undertaken	Explosive Power Tool Practical Assessment	Work location	Basement
Job Activity	*Hazards*	*Safety Controls*	
1. General planning	Inadequate qualifications and/or experience	Completion of theory training session to familiarise trainee in operation and handling	
2. Select appropriate PPE	Ear, eye and foot injury	Boots, safety glasses, hearing protection and clothing in accordance with WHS requirements	
3. Secure worksite	Injury to persons not involved in assessment	Barriers and signage in place Ensure area down range of the fastenings is clear of people (6 m)	
4. Colour vision test	Incorrect selection of charges	Test to assess colour perception	
5. Pre-operational inspection	Tool damaged	Safety features checked for serviceability, faults reported to supervisor	
6. Operation of power tool	Suitability of material to be fixed Incorrect selection of fastening Incorrect selection of charges Fastening breaks through edge of material	Brittle and/or soft materials excluded. Appropriate type and length of fastening Use low charge for initial test firing to determine correct charge for particular material Keep fastenings at safe distances from edge of material	
7. Misfire	Accidental delayed firing of charge	Pressure on tool maintained for 10 seconds after misfire	
8. Post-operation procedure	Live charge left in tool Damaged tool stored	Tool cleared, cleaned and stored to the manufacturer's recommendations Tool lubricated, serviced and logbook checked to specifications Misfired charges disposed of appropriately	
Codes of Practice, Legislation and Standards applicable	AS/NZS 1873: 2003 Powder-actuated (PA) hand fastening tools		

Appendix 2: Practical skill assessment

Applicant:	*Date:*	*C.*	*N.Y.C.*
1. Apply hazard identification, risk assessment and appropriate control measures			
2. Explain and apply a safe work method statement (as supplied by the assessor) which is appropriate to the assessment event			
3. Select the correct tool for the assessment activity and dismantle			
4. Clean and inspect			
5. Assemble tool			
6. Demonstrate compliance with WHS requirements			
7. Demonstrate the ability to identify potential hazards, both personnel and materials			
8. Demonstrate an ability to differentiate between different coloured charges			
9. State the selection of the correct charge for: – Timber to steel_____ – Timber to concrete_____ – Steel to concrete _____			
10. Select correct charge for the assessment activity			
11. Load tool			
12. Simulate correct firing position			
13. Misfire procedures stated			
14. Unload tool			
15. Reload tool			
15. Demonstrate safe live fire			
16. Pack tool for transport			
17. Assessors comments:			

Glossary

base material the material into which the fastener shaft is driven

charge a cased cartridge of explosive, specifically designed for a powder-actuated hand-held fastening tool. May also be referred to as an ***explosive charge*** or ***power load***

contact force the force applied to the tool by the operator to prepare the tool for firing

fastener stud, nail or pin designed to be driven into or through base material by a powder-actuated fastening tool

JSA job safety analysis

misfire failure of the charge to ignite when the tool is fired

PCBU person conducting business or undertaking

spall area of damaged concrete resulting from previous fasteners

SWMS safe work method statement