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PASA
Powder Actuated Systems Association

Guide to Basic Training

POWDER ACTUATED FIXING SYSTEMS

The Powder Actuated Systems Association

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Membership List

Hilti (Gt. Britain) Ltd	Ramset Fasteners Ltd
Impex Suprafast Ltd	Spit Fixings (A Division of ITW Ltd)
ITW Redhead	Tornado Fixings Ltd

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General Background

PASA is an Association affiliated to the federation of British Hand Tool Manufacturers of companies engaged in the supply of powder actuated systems to the Construction Industry. The aims of the Association are:

1) To promote safe use of fixings and tools
2) To promote good fixing practice
3) To promote improved standards and presentation of technical information.

Purpose of the Guide to Basic Training

One of the most important factors in achieving safe, satisfactory use of powder actuated fixing systems is operator training. Since the fundamentals applicable to the use of all powder actuated fixing systems are basically the same, this guide is designed to provide the basic training which is common to all systems.

Supplementing this basic programme, each member company provides training on the operation, care and maintenance of its own individual systems and will issue appropriate certificates on completion of training.

The purpose of this guide is to give practical guidance for promoting safety at work. It is not intended that it should be used either as a commentary on matters of civil liability, or as any indication that non-observance or observance of the guide will or will not give rise to such liability.

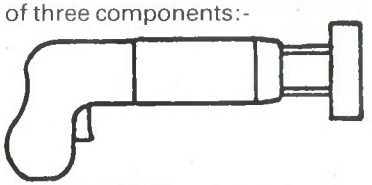
Contents

1 Introduction to Powder Actuated Fixing Systems

These systems are widely used as a fast and efficient method of making fixings into various construction materials. Although such systems are simple to use, there are precautions and safeguards that must be observed. This guide provides only the basic training.

Any system consists of three components:-

1 A Tool



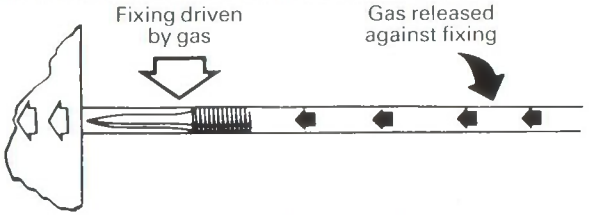
2 A Fixing

3 A Cartridge

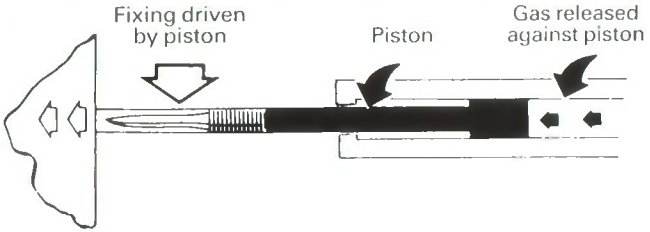
2 Tools

There are two general types of tool:-

a. **Direct Acting Type** – A tool in which the expanding gas of a cartridge acts directly on the fixing to be driven into the base material.



b. **Indirect Acting Type** – A tool in which the expanding gas of a cartridge acts on a captive piston which in turn drives the fixing into the base material.



Safety Notes:

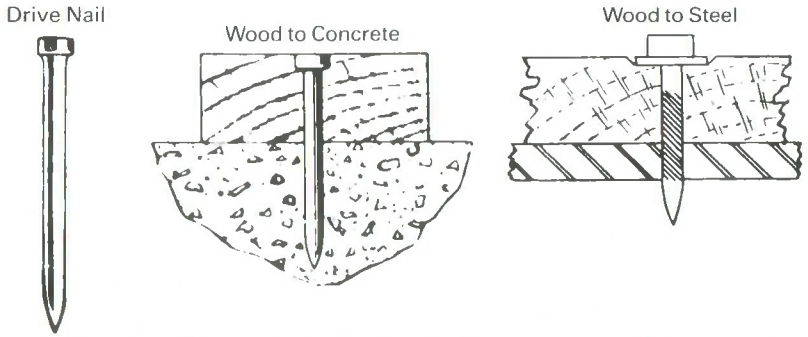
(1) Always make sure you know which type of tool you are using.
(2) Because of the difference in the two principles (Direct and Indirect Acting), the former type usually results in a much higher exit velocity of the nail from the muzzle of the tool, and greater care should be exercised when tools of this type are used.
(3) Wherever possible use a safety shield.

3 Fixings

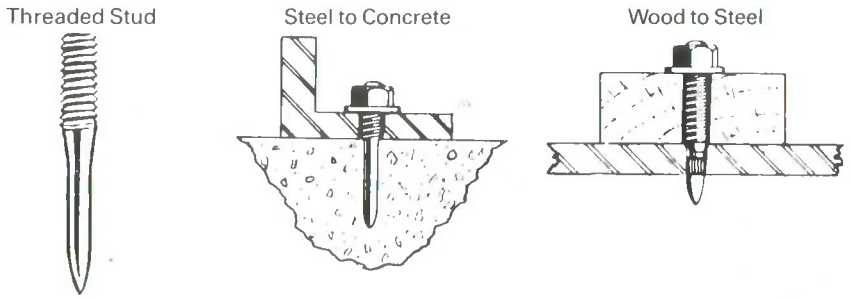
Being intended to penetrate hard surfaces such as a mild steel and concrete, as well as timber, pins for use in cartridge-operated tools have different physical properties to the commonly used nails, and these properties are matched to the ballistic characteristics of the tool. The characteristics are necessary to permit the fixing to penetrate concrete or steel without breaking. The fixing is fitted with a cap, washer or similar guide member to align the fixing in the tool as it is being driven. The guide is also used to retain the fixing in the tool. Each tool manufacturer markets a wide range of pins, studs, eyelets, etc., which are intended for use with the tools produced by that firm and there are, in addition, firms which only manufacture pins. Before attempting to use pins not made or catalogued by the makers of their tools, users should ensure that the properties are at least equivalent to the manufcaturers specification. The use of an unsuitable pin could result in it shattering instead of penetrating the working surface, producing dangerous fragments.

There are three main types of fixing:—

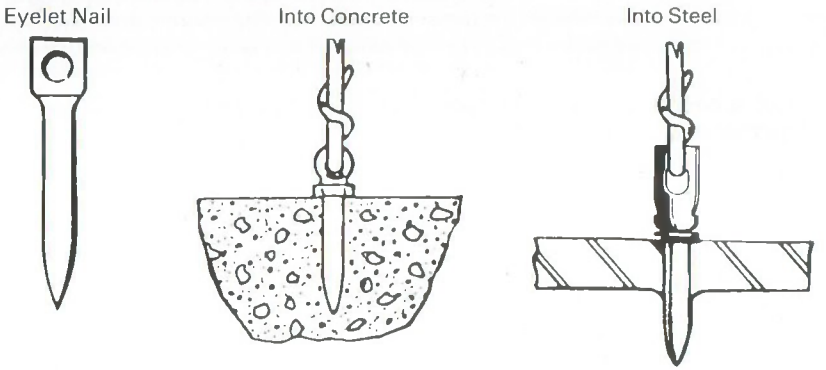
a. **Drive Nails** – Fixings designed to attach one material to another, such as wood to concrete or steel. For additional strength in conjunction with soft base materials, washers of various diameters are either fastened through or are made part of the drive nail assembly.



b. **Threaded Studs** – Fixings which consist of a shank portion which is driven into the base material and a threaded portion which will accept a nut.

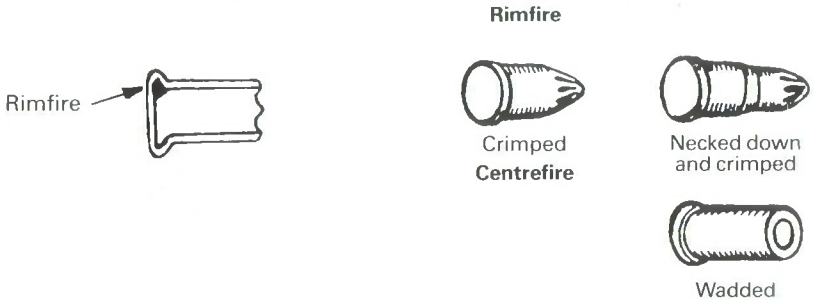


c. **Eyelet Nails** – Fixings with a hole through which wire can be passed for hanging ceilings, light fixtures, etc.



4 Cartridges

There are various types of cartridges currently available which are shown below. Cartridges can be supplied as single shots or jointly in a magazine or strip.



The following chart gives a simple letter/colour code for identification:

Extra Low	XL	Brown
Low	L	Green
Low-Medium	LM	Yellow
Medium	M	Blue
Medium High	MH	Red
High	H	White
Extra High	XH	Black

Safety Note:

The colour code above is taken from BS4078 1966 'Design of Cartridge operated tools'. American and European colour codes can differ and you should check with the tool manufacturer if there is any doubt. When testing, always use a low strength cartridge first.

5 Suitable Base Material

The material into which the fixing shank is driven and from which the holding power is obtained is known as the base material. To ensure safety and reliablilty, it is important that the operator can identify which materials are suitable for a given fixing.

a) Suitable base materials, when pierced by the fixing will expand and/or compress and have sufficient hardness and thickness to produce holding power and will not allow the fixing to pass through. Concrete and mild steel are usually suitable base materials.

b) Unsuitable base materials can be put into three categories:—

(i) Those which are too hard – The fixing will not be able to penetrate and could possibly deflect or break.
Examples: Hardened steel, welding, cast steel, marble, rock, some brick, white iron.

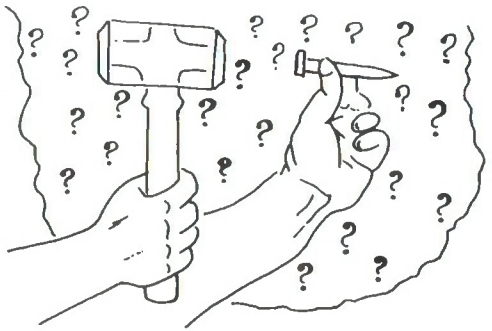
(ii) Those which are too brittle – The material will crack or shatter and the fixing could either deflect or pass straight through.
Examples: Glass, glazed tiles, slate, etc.

(iii) Those which are too soft – The material has insufficient holding power and the fastener could pass straight through.
Examples: Plaster, plywood, hardboard, lightweight building blocks.

A very simple test can quickly be made to establish whether a base material is suitable. The point of the fastener should be hammered firmly onto the material to be tested.

1. If the material shows a clear fastener point impression and the fastener point is not blunted a test fixing should be made.
2. If the fastener point is blunted the material is **too hard**.
3. If the material shows signs of cracking, the material is **too brittle**.
4. If the fastener sinks into the material with an average hammer blow, the material is **too soft**.

The same tests should also be carried out on the material to be driven through and attached to the base material, unless the material is known to be soft.



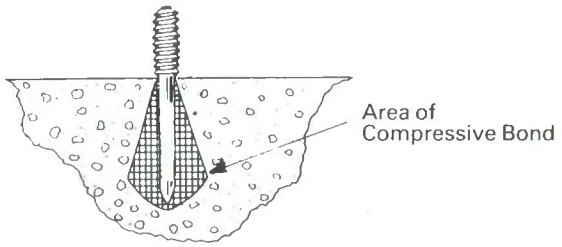
Unknown or questionable base material
Centre punch material with fastener

Safety Note:

If you are in any doubt – do not guess, contact your immediate supervisor who will be able to contact your manufacturers representative for advice.

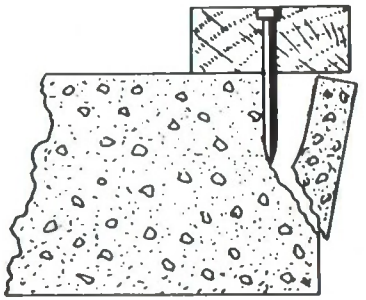
6 Fixing into Concrete and Masonry Materials

The holding power of a fixing results primarily from the compressive forces within the concrete or masonry acting on the fixing shank. On penetration, the fixing displaces the masonry which tries to return to its original form and thereby exerts a compressive effect. This holding power is affected by the depth of penetration, the compressive strength of the base material, the size of aggregate in the base material, the diameter of the fixing shank and the spacing of fixings.



The most favourable depth of penetration of fixings into concrete ranges between 22-32 mm (⅞-1¼in.), into masonry, the necessary penetration will be about 50 mm (2in). It should, however, be determined on a trial and error basis.
Concrete with a compressive strength of less than 10 N/mm² is only suitable for low performance fixings. Concrete with a comprehensive strength of greater than 60 N/mm² is unsuitable for powder actuated fixings.
From the guidelines above, it is clear that fixings with different diameters will require different penetration depths and that the appropriate cartridge strength must be selected to achieve the correct penetration in a particular base material. The correct combination can usually be obtained by actual tests on the job but if any doubt remains OBTAIN EXPERT ADVICE.
When fixing into masonry or concrete, it is important to remember the following basic facts for safe and efficient results.

A **Wherever possible use a safety shield**
B **Do not fix closer than 75 mm from the edge of the base material**

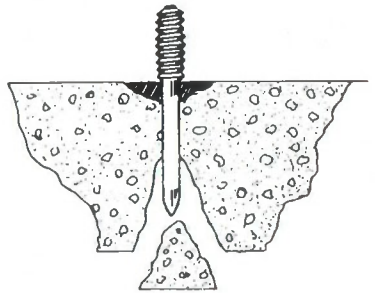


C **Setting fixings too close together can cause the base material to crack**

Shank Diameters	Minimum Distance between fixings
Up to 4 mm (5/32")	75 mm (3")
Over 4 mm	100 mm (4")

As a general rule the minimum spacing of fixings should be 2 × penetration depth.

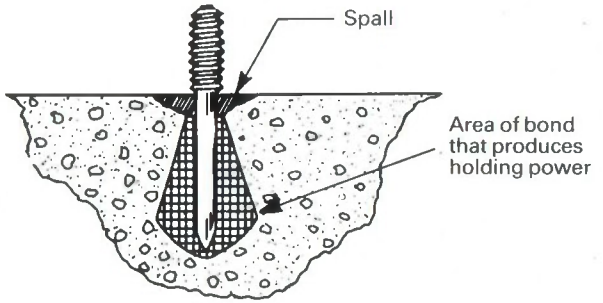
D **It is important that when the base material is concrete or masonry it is at least twice as thick as the intended penetration**



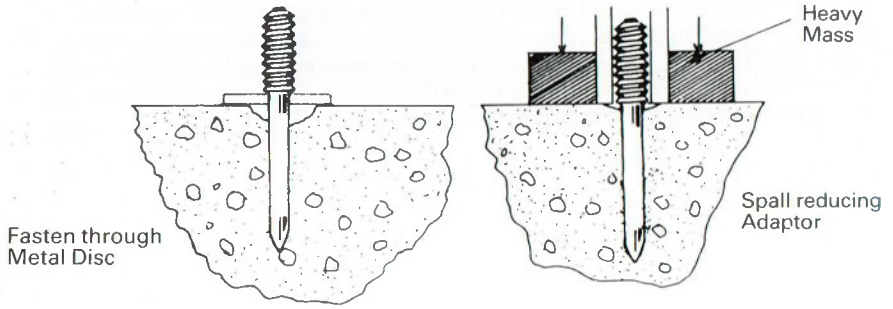
E **Fixing into mortar joints should be avoided**

F **Surface Problems**

Spalling, the breaking of masonry or concrete on the surface, is caused by the compressive effect of the penetration of the fixing, particularly on the initial impact with the base material.



Spalling of the concrete can reduce the holding power by up to 20%.
Spall may be reduced as follows:-
– Use a smaller shank diameter fixing.
– Use a weaker cartridge or a shorter shank length, or a combination of both, since over penetration may be a cause of the spall.
– Fix through a metal disc or washer.
– If persistent problems occur a heavy spall-reducing adaptor may be fitted to the tool.



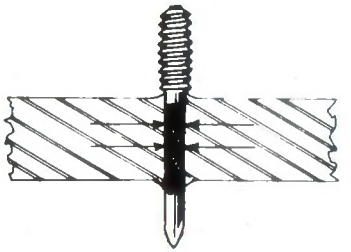
G **Internal problems in Concrete**

Exceptionally hard aggregrate, reinforcing rods and cables, etc., may cause a problem known as 'fishhooking' which occurs when a partially driven fixing hits a hard object within the concrete causing the fixing to bend. The following action may be taken to reduce the problem:—
– Reduce shank penetration to miss obstruction.
– Increase the shank diameter.
– Reduce the cartridge strength to avoid over penetration.
– Fix through a metal disc.
– Consider whether the site of the fixing may be relocated to a more suitable position.

H **Fixing into pre-stressed concrete should be avoided.**

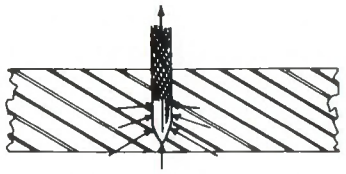
7 Fixing into Steel

Most fixings driven into steel as a base material are driven into structural steel which may usually be found in the form of beams, angle iron, channel, tee, plate and strip. If fixings are to be driven into metal materials other than structural steel, a suitability test on hardness should be carried out and, if in doubt, the supplier of the metal should be contacted for advice.
As the fixing is driven into steel there is a defomation of the steel displaced by the point and shank of the fixing. Because of the elasticity of steel it grips the shank of the fixing immediately after the driving process.



The holding power is directly affected by the total contact area between the shank of the fixing and the steel. If follows that an increase in the diameter of the fixing or

the depth of penetration will increase holding power. However, it is important that the diameter of the shank must not exceed the thickness of the steel. In order to get maximum strength the pointed portion of the shank should extend through the steel. If the point remains embedded in the steel, the compressive forces acting on the point will tend to force the fixing back out.



In certain cases it may be necessary to fix into thick steel where it is not possible for the point to completely penetrate. In such cases a good fixing can be achieved providing the depth of penetration of the fixing is sufficient to overcome the negative force of the embedded point.
To obtain the best combination of fixing size, depth of penetration and power load strength for a specific application it is advisable to consult your manufacturer's technical data, and if necessary to undertake tests on the actual material involved.

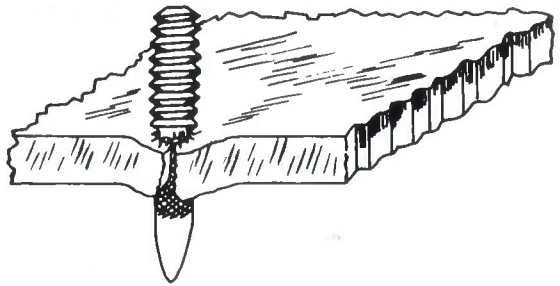
Safety Note:

If you are in any doubt – do not guess, contact your immediate supervisor who will be able to contact your manufacturers representative for advice.

When fixing into steel it is important to remember a few basic facts to assure safe and efficient results.

1 **Do not fix too close to the edge of steel**

The steel between the fixing and the edge can stretch so that it will not grip the fixing shank or the steel may snap allowing the fixing to escape. In neither case can a good fixing be obtained.



In most circumstances the distance of the fixing from the edge should be two and a half times the diameter of the shank.

2 **Do not set fixings too close together**

The compressive effect of one fixing may loosen a previous fixing. It is recommended that the *minimum* spacing between fixings should be six times the shank diameter.

3 **Avoid overdriving the fixing**

A fixing driven with excessive force can be damaged or even break.

4 **Do not drive a fixing in areas that have been welded or torch cut.**

Welding or torch cutting can produce areas which may prove to be too hard for powder actuated fixing.

5 **Do not use fixings to draw bossed steel members together.**

6 **Do not fix into a steel base, material which is thinner than the diameter of the fixing shank.**

7 **Do not use fixings with a shank longer than required.**

A long shank passing through steel enlarges the hole and reduces the holding power of the fixing.

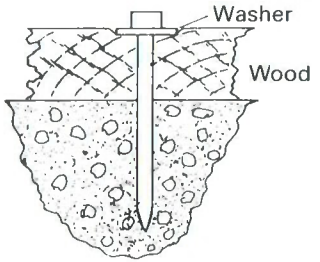
8 **Do not fix into existing holes unless a guide to centre the tool is used.**

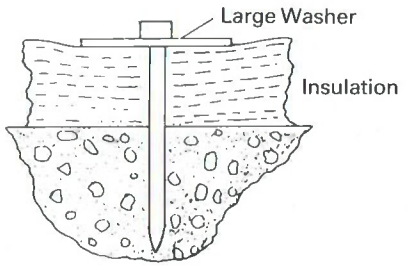
8 Applications

Most applications for powder actuated fixing systems fall into one of the following classifications:

a **Fixing relatively soft material such as wood or insulation**

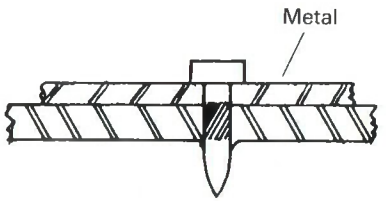
Whether driving into concrete or steel, a good fix may require the use of a washer. The size of the additional washer will depend on the softness of the material.

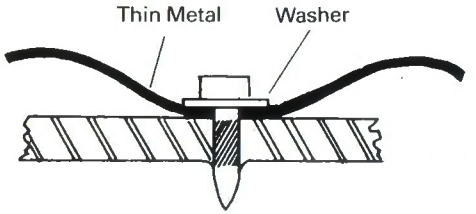




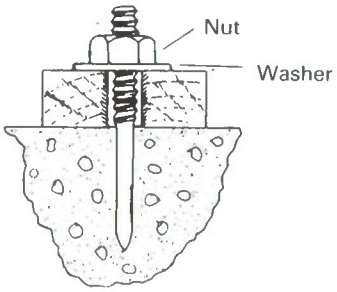
b **Fixing metal to concrete or steel**

If the material is quite hard, the fixing will be sufficient to obtain a good fixing. If thin sheet is being fixed, however, it may be desirable to fix an additional washer.





c **Fixing removable items to concrete or steel**
The selection of a washer size, if any, required under the nut will depend upon – the softness of the material.



Caution:
Overtightening a nut on a threaded stud will pull out the stud from the base material.

9 Summary of Basic Safety Precautions

Powder actuated tool systems are designed to operate safely. To use these systems safely you need to:

1 Use common sense and good judgement.
2 Use the tool as recommended for its intended purpose only.
3 Know the material being fixed and the base material into which the fixing is to be made.

The following specific precautions should be remembered and practiced.

The Operator

1 Operators should be over 18 not colour blind and should have been trained and be competent in the use of the specific tool to be used.
2 Operators should always wear safety goggles.
3 Use of ear protection is recommended when making fixings in confined areas.
4 Never let bystanders gather round when using a tool.
5 It is recommended that when fixing into a wall or partition, the other side of the wall to the working face should be fenced off to prevent anyone from entering the area unseen by the person using the tool. No bystanders should be permitted in the immediate vicinity of the tool, and it may be necessary for the sides of the working area to be screened, as a protection against possible ricochet.
6 When working on ladders or scaffold which should be properly secured, maintain good balance and brace yourself at all times.
7 Never load the tool until you are ready to make a fixing.
8 Always keep tool pointed in a safe direction.
9 Never carry a loaded tool from job to job.
10 Wherever possible use a safety shield or manufacturers special application adaptor.

Further valuable advice is available in Health and Safety executive guidance note PM14 "Safety in the use of cartridge operated fixing tools" available from H.M.S.O. or their agents.

Care and Servicing of Tools

1 All tools should be cleaned and maintained in accordance with the manufacturers instructions.
2 Always check tools prior to use to ensure they are in good working order.
3 Defective tools must be removed from service until repaired.
4 Do not alter any tool or attempt to repair it unless you use parts made by the tool manufacturer. To do so could destroy its safety features and invalidate any warranty.
5 Tools should be stored unloaded in a locked container when not in use.

Use of Tools

1 Always use the tool at right angles to the work surface.
2 Always check the chamber before loading.
3 Do not use the tool in an explosive or inflammable atmosphere.
4 Never place your hand over the front (muzzle) end of a loaded tool.
5 Tools of the direct acting type should always be equipped with a safety shield.

Use of Fixings

1 Always ensure that nails and studs correspond to the specifications issued by the manufacturer of the tool.
2 Always ensure that the dimensions of the fixing correspond with the tool to be used.

Use of Cartridges

1 Always check the colour of the cartridge before inserting it into the tool and check the appropriate colour code for strength.
2 Always make your first trial fixing with the weakest or lowest power grading.
3 Never attempt to force a cartridge into a tool.
4 In the event of a mis-fire, hold the tool firmly against the work surface for a period of 30 secs., and then follow the explicit instructions issued by the manufacturer. Unfired cartridges should not be carelessly discarded.
5 Never carry cartridges in a container or pocket with metal objects such as fixings.
6 Always ensure that the cartridges correspond to the specifications issued by the manufacturer of the tool.

Materials

1 Before fixing into any unidentified material, carry out a suitability test.
2 Never attempt to fix into a spalled or cracked area of concrete or into an area where a previous fixing has failed. To do so could cause the fixing to fish-hook or ricochet.

General

1 Always follow the rules for edge distance, fixing spacing and material thickness.
2 Never overdrive a fixing.
3 Do not use a fixing to draw down a steel member in view of the tension involved.
4 Never over-tighten a nut on a threaded stud.
5 Do not attempt to install fixing into very hard or brittle material.
6 Never fasten soft materials onto a soft or thin base material.

BE SAFE

Check your knowledge—

turn to the

Operator Check List

Operator Check List

Having read the PASA "Guide to Basic Training for Powder Actuated Fixing Systems", it is recommended that potential operators should assess their general knowledge and understanding of good fixing practice by completing the following questionnaire. The answers are given on page 20.

1 *Fixings used in powder actuated tools are:*
(a) Common nails with washers.
(b) Manufactured from special steel and hardened.
(c) Very hard and brittle.

2 *A drive nail is a fixing which is used to:*
(a) Insert a wire for suspending a ceiling.
(b) Permanently attach one material to another.
(c) Attach one material to another with a nut.

3 *Complete the following cartridge strength identification, to current British Standards:*

Green=	Black=
Red=	Yellow=

4 *When selecting a cartridge, should you first choose:*
(a) The one you think may be correct.
(b) The strongest cartridge or the highest power setting for the tool.
(c) The lightest cartridge or the lowest power setting for the tool.

5 *Shields are used to:*
(a) Confine flying particles.
(b) Reduce recoil.
(c) Reduce operator fatigue.

6 *Which, if any, of the following materials is suitable for powder actuated fixing:*
(a) Poured concrete.
(b) Hollow tiles.
(c) Surface hardened steel.
(d) Glazed brick.

7 *How would you assess the suitability of a base material if, on testing:*

(i) The fixing is blunted –	material is (a) soft (b) hard (c) brittle
(ii) The fixing penetrates easily –	material is (a) soft (b) hard (c) brittle
(iii) The material cracks –	material is (a) soft (b) hard (c) brittle

8 *When fixing into average concrete, the recommended fixing shank penetration for good power should be:*
(a) 18-22 mm (3/4-7/8in.)
(b) 22-32 mm (7/8-1 1/4in.)
(c) 32-36 mm (1 1/4-1 3/8in.)

9 *In masonry, a fixing should be driven no closer to an unsupported edge than:*
(a) 12 mm (½in.) (b) 38 mm (1½in.) 75 mm (3in.)

10 *When fixing into masonry, the base material thickness should be at least equal to*
(a) The penetration of the shank.
(b) Twice the penetration of the shank.
(c) Two and half times the penetration of the shank.

11 *Which of the following factors causes* least *spall when fixing into masonry:*
(a) Fixing compressing the masonry.
(b) Fixing striking surface aggregate.
(c) Over penetration due to excessive power.
(d) Driving fixing through a disc.
(e) Use of a spall stop.

12 *Which of the following actions to reduce "fish-hooking" is correct:*
(a) Reduce penetration and increase shank diameter.
(b) Increase penetration and reduce shank diameter.

13 *When fixing into steel the fixing point should normally fully protrude because:*
(a) Fixing removal is easier when required.
(b) Any embodied part of the point tends to force the fixing out.
(c) It prevents overtightening of the nut.

14 *How close to the edge of steel is fixing recommended.*
(a) Two and a half times the shank diameter.
(b) Three times the shank diameter.
(c) Four times the shank diameter.
(d) Six times the shank diameter.

15 *Do not drive fixings into steel thinner than:*
(a) Two times the shank diameter.
(b) One and half times the shank diameter.
(c) The shank diameter.

16 *When fixing soft materials into masonry or steel a washer helps because:*
(a) It increases penetration.
(b) It improves the appearance.
(c) It provides a greater bearing surface and increases the pull-over value.

17 *If a tool is found to be defective in any way, you should first:*
(a) Call for assistance.
(b) Try to mend the tool as best you can.
(c) Stop using it immediately.

18 *A powder actuated tool should be carefully checked to see it is in proper working condition prior to each days use:*
(a) True (b) False

19 *When operating a tool neither hand should be placed:*
(a) Around the tool body.
(b) In front of the tool muzzle.
(c) Over the assembly lock.

20 *If a loaded tool fails to fire:*
(a) Keep trying until it does.
(b) Immediately unload and release it.
(c) Hold it against the work surface for 30 seconds then follow the manufacturers instructions.

21 *Which one of the following safety rules is incorrect?*
(a) Hold tool perpendicular to the work surface.
(b) Avoid holes or spalled areas.
(c) Make test fixing with the strongest cartridge.
(d) Avoid welds and torch-cut areas.
(e) Avoid driving into soft or thin base materials.

Answers overleaf.

Self Assessment Answers to the Operator Check List

1 (b)

2 (b)

3 Red = Medium – High

Black = Extra – High

Yellow = Low – Medium

Green = Low

4 (c)

5 (a)

6 (a)

7 (i) b (ii) a (iii) c

8 (b)

9 (c)

10 (c)

11 (d & e)

12 (a)

13 (b)

14 (a)

15 (c)

16 (c)

17 (c)

18 (a)

19 (b)

20 (c)

21 (c)