

ABRASIVE WHEELS

FOR ANGLE GRINDERS AND CUT OFF SAW

COURSE HANDBOOK

SECOND EDITION



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COURSE HANDBOOK

SECOND EDITION 2011

C. N. PERRY MBA PgD CMIOSH AIIRSM RMaPS

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The table is extracted from the HSE publication HSG 17 “Safety in the use of Abrasive Wheels”

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LEGAL REQUIREMENTS

The following extracts from legislation provide the basis for the need to train those who use and change Abrasive Wheels.

Health and Safety at Work Act 1974 (HASAWA)

To provide and maintain plant and systems of work that are so far as reasonably practicable, safe and without risks to health (s.2(2)(a))

To provide such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of all employees (s.2(2)(c.))

Provision and Use of Work Equipment Regulations 1998

Every employer SHALL ensure that all persons who use work equipment have received adequate training for the purpose of health and safety, including training in the methods which may be adopted when using work equipment, any risks which such use may entail and precautions to be taken. This includes supervisors and managers.

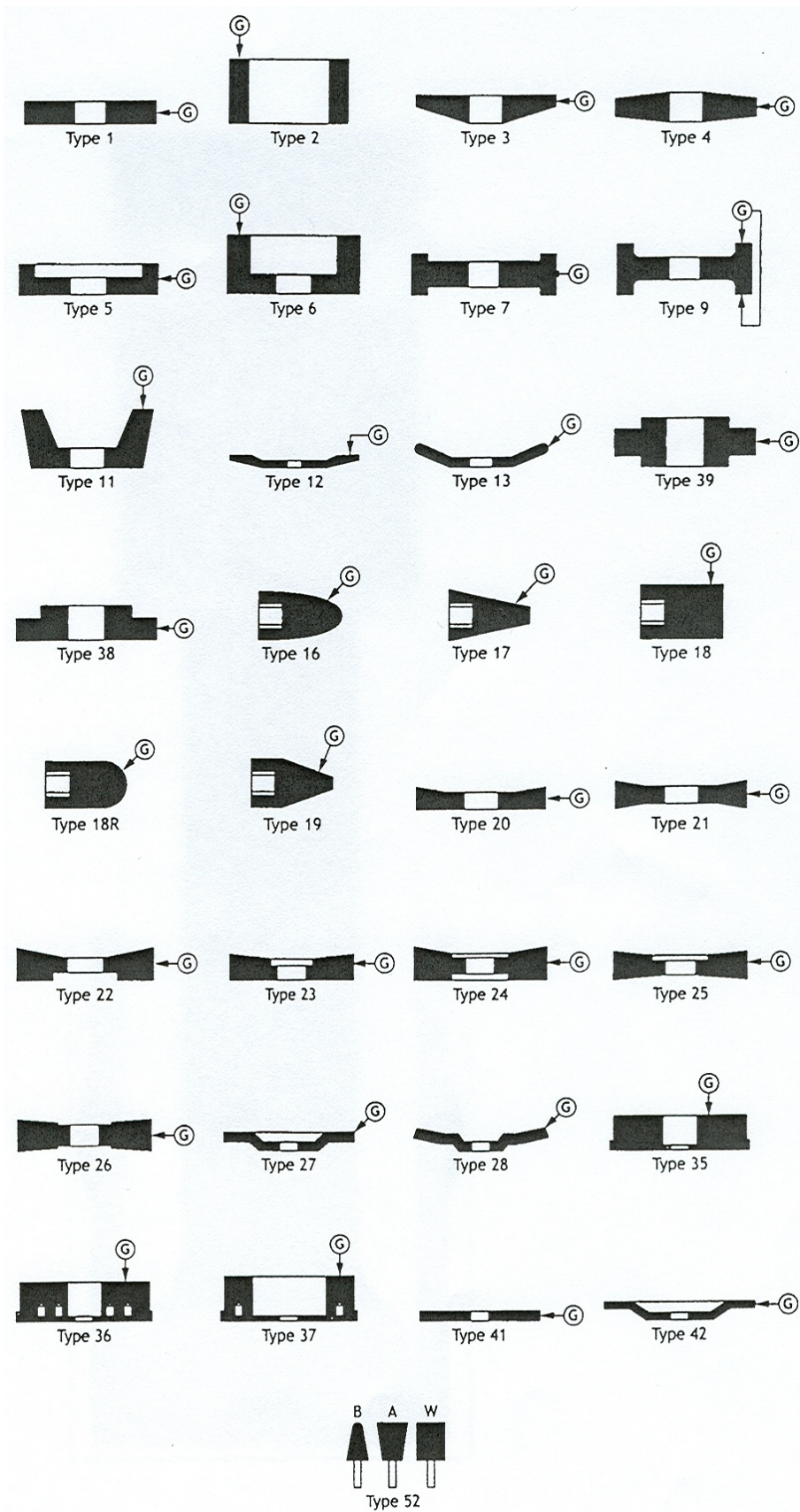
(regulation 9)



Key Fact

These regulations are enforceable by law and apply in all workplaces as this is where the Health and Safety At Work Etc. Act 1974 applies

ABRASIVE WHEEL TYPES AS BS EN 12413 1999 (Table 12)



Ⓒ denotes grinding face

HAZARDS AND RISKS ASSOCIATED WITH ABRASIVE WHEELS

Contact with the rotating wheel.

The abrasive wheel rotates at high speed and is capable of causing severe injuries if it comes into contact with flesh. This is particularly important for hand held tools such as angle grinders which have abrasive wheels which rotate at extremely high speed. Keep away from the rotating wheel.

Wheel breakage and resulting wheel pieces.

Should the wheel break the resulting pieces are likely to be ejected at high speed and are capable of causing severe wounds and can kill as the speeds of ejection can be as high as 80 to 100 miles per hour. Always use safe systems of work when mounting Abrasive Wheels to minimise the possibility of wheel breakage.

Ejection of particles and or the workpiece.

The Abrasive Wheel sheds particles as it works and wears down. These are usually seen as sparks and are capable of causing damage to bare skin and are particularly damaging if in contact with the eyes. The workpiece can also be ejected from the machine at high speed.

Always use the correct Personal Protective Equipment (PPE) and keep the rest correctly adjusted as close to the Abrasive Wheel as possible. Use a vice to secure the workpiece when using an angle grinder or ensure it is in some other way secured firmly

Drawing in.

Any item which comes into contact with the rotating wheel may be wrapped around it and drawn into the wheel. If this is a something attached to the operator they will be Drawn into the wheel and injured. Keep all loose equipment and loose clothing, hair, jewellery etc. away from the wheel.

Entanglement.

Any item which comes into contact with the rotating wheel may be wrapped around it and become entangled with wheel. If this is a something attached to the operator they will be Drawn into the wheel and injured. Keep all loose equipment and loose clothing, hair, jewellery etc. away from the wheel.

Dust and Noise.

Dust produced by certain operations can be significant. Use the correct grade of mask to protect from the dust. To protect against noise see the manufacturer's literature for the noise level they propose and if required conduct a noise survey to select the correct hearing protection required.

Vibration

Hand held angle grinders subject their users to Hand Arm Vibration as these machines are hand held. It is necessary to carry out a risk assessment to determine the times to reach the two stated values, the action value and the limit value. This handbook contains a sample of a Risk Assessment.

FUNCTIONS OF COMPONENT

PORTABLE GRINDERS – ANGLE GRINDERS

The Machine.

The actual grinding machine must be a correctly manufactured piece of equipment. The Abrasive Wheel must be mounted on the machine for which it is intended. Do not use makeshift equipment. The machine must also be safe from all perspectives not just an Abrasive Wheels perspective.



Key Point

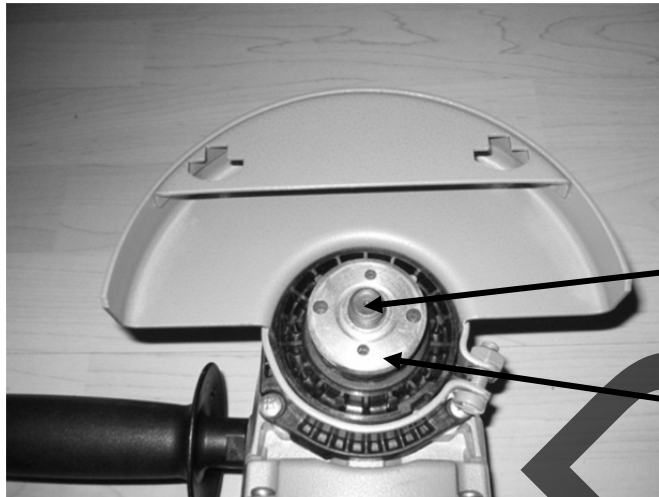
All Angle Grinders must have guards designed for the machine fitted and correctly adjusted before use.



Wheel Lock Mechanism

The Spindle.

Spindles must run true in their bearings and rotate freely, be undamaged especially in respect of the threads. The threads should be undamaged for their full length. The base of the spindle should be matched to the bottom flange so this spindle seats correctly. The spindle should be long enough to allow the top flange to engage fully on the thread.



Spindle

Flanges

Machine bearings

These must be maintained in good order and be free from defect and wear.

Flanges.

These secure the Abrasive Wheel and should be a matched pair which were supplied with the machine. The flanges must be recessed or undercut such that there is no pressure on the edge of the hole in the wheel. The undercut is shown. The top flange is different on

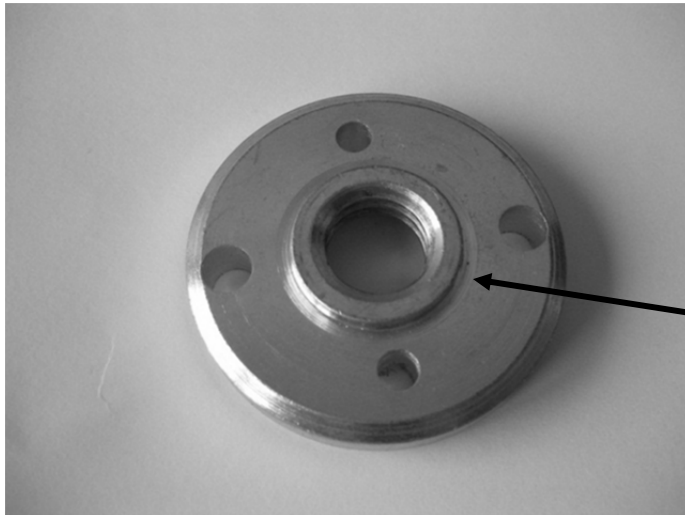
both sides. This is to allow for the difference in thickness between cutting wheels that are thinner and grinding wheels which are thicker. Both have metal reinforced centres. Note that the top flange is threaded.



Key Point

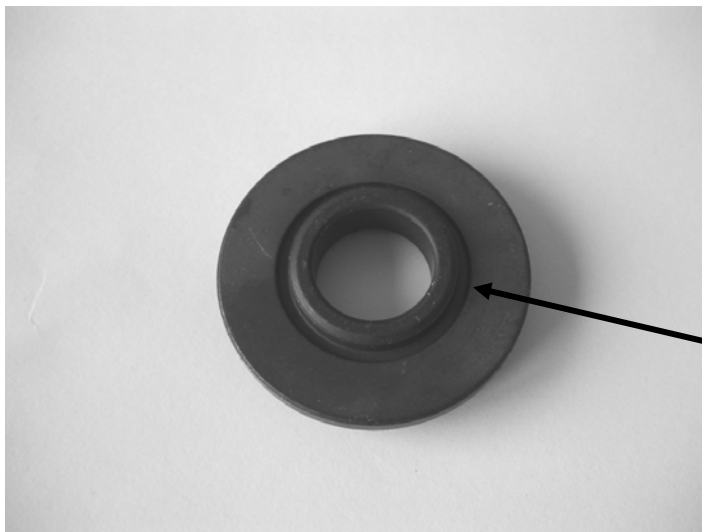
When changing from a grinding wheel to a cutting wheel remember to turn the outer flange over as the cutting wheel is thinner. If you do not do this the flanges will not grip the abrasive wheel correctly

Top Flange.



Undercut

Bottom Flange



Undercut

Wheel Lock Mechanism

The Angle Grinder has a mechanism to allow the user to lock the wheel to allow the outer flange to be removed with the tool provided. This is shown in the first picture showing the angle grinder

CUT OFF SAW

The Machine.

The actual grinding machine must be a correctly manufactured piece of equipment. The Abrasive Wheel must be mounted on the machine for which it is intended. Do not use makeshift equipment. The machine must also be safe from all perspectives not just an Abrasive Wheels perspective.



Key Point

The Guard moves up as the machine is used. The guard must be free to move up and down before the machine is used. If not then the machine is not safe to use.

The Spindle.

Spindles must run true in their bearings and rotate freely, be undamaged especially in respect of the threads. The threads should be undamaged for their full length to allow the set screw to fully tighten. The base of the spindle should be matched to the bottom flange so this spindle seats correctly. The spindle should be long enough to allow the outer flange to just locate as it is not circular but has flats on it to locate on the spindle. The set screw fits an internal thread in the spindle, unlike either a Bench Grinder or an Angle Grinder and has a washer.

Machine bearings

These must be maintained in good order and be free from defect and wear.

Flanges.

These secure the Abrasive Wheel and should be a matched pair designed for the machine. The flanges must be recessed or undercut such that there is no pressure on the edge of the hole in the wheel.

Wheel Lock Mechanism

The Cut Off Saw has an integral wheel lock mechanism, in the same way as does an angle grinder to allow the user to lock the wheel to undo the set screw.

Shown overleaf is a Cut Off Saw with the wheel removed and the components on top of the wheel, this is followed by a photograph of the wheel lock mechanism



ABRASIVE WHEEL CHARACTERISTICS

An abrasive wheel is usually defined as a wheel consisting of abrasive particles bonded together with various substances. There are two main types of bonding agent: inorganic and organic.

Inorganic bonds are mainly vitrified i.e. the wheel is generally fired in a furnace to give the bond a hard, strong but brittle structure. These wheels are used for precision grinding applications as they hold their shape, but require dressing.

Organic bonds are not fired but cured at low temperature; the bonding agents are resinoid (B) rubber [R] and Shellac (E). Such wheels are tough, shock resistant and self dressing, and are most suited to non precision applications such as fettling and cutting off.

The following terms are the variable elements in abrasive wheel manufacture. Full details can be found in clause 5.5 of BS ISO 525 1999.

Abrasive

This means the type of abrasive used in the construction of the wheel. Two forms of abrasive material are in common use;

Aluminium Oxide for grinding high tensile materials such as carbon and alloy steels.
Annealed malleable iron and some aluminium and bronze alloys.

Silicon Carbide. For grinding cast iron, non ferrous metals and non metallic materials.

Grain/Grit Size

This means the particle size of abrasive grains. The range is expressed by number i.e. Very coarse 4 to very fine 1200. The grits are sieved to separate the grain sizes. Coarse grades are for rapid material removal and fine for an improved surface finish. A fine grain wheel will hold its shape for longer than a coarse grade wheel.

Grade

This represents the tenacity with which the bonding material holds the abrasive grain in a wheel. Wheels are graded as 'soft' to 'hard' according to the degree of their tenacity. The grade scale is expressed alphabetically from the letter A denoting extremely soft to Z denoting very hard.

A soft wheel gives up its abrasive particles more easily than a hard wheel. The bond should give up the abrasive particle when it is no longer sharp. Too soft a wheel will wear too quickly before the abrasive particles are worn where as a hard wheel will keep its particles after they have become blunt and will glaze. This glazing can leads to excessive heat at the surface of the wheel.

Structure

This means the level of porosity in the wheel. The higher the number the greater the level of porosity. The structure also assists with the releasing of the abrasive particles.

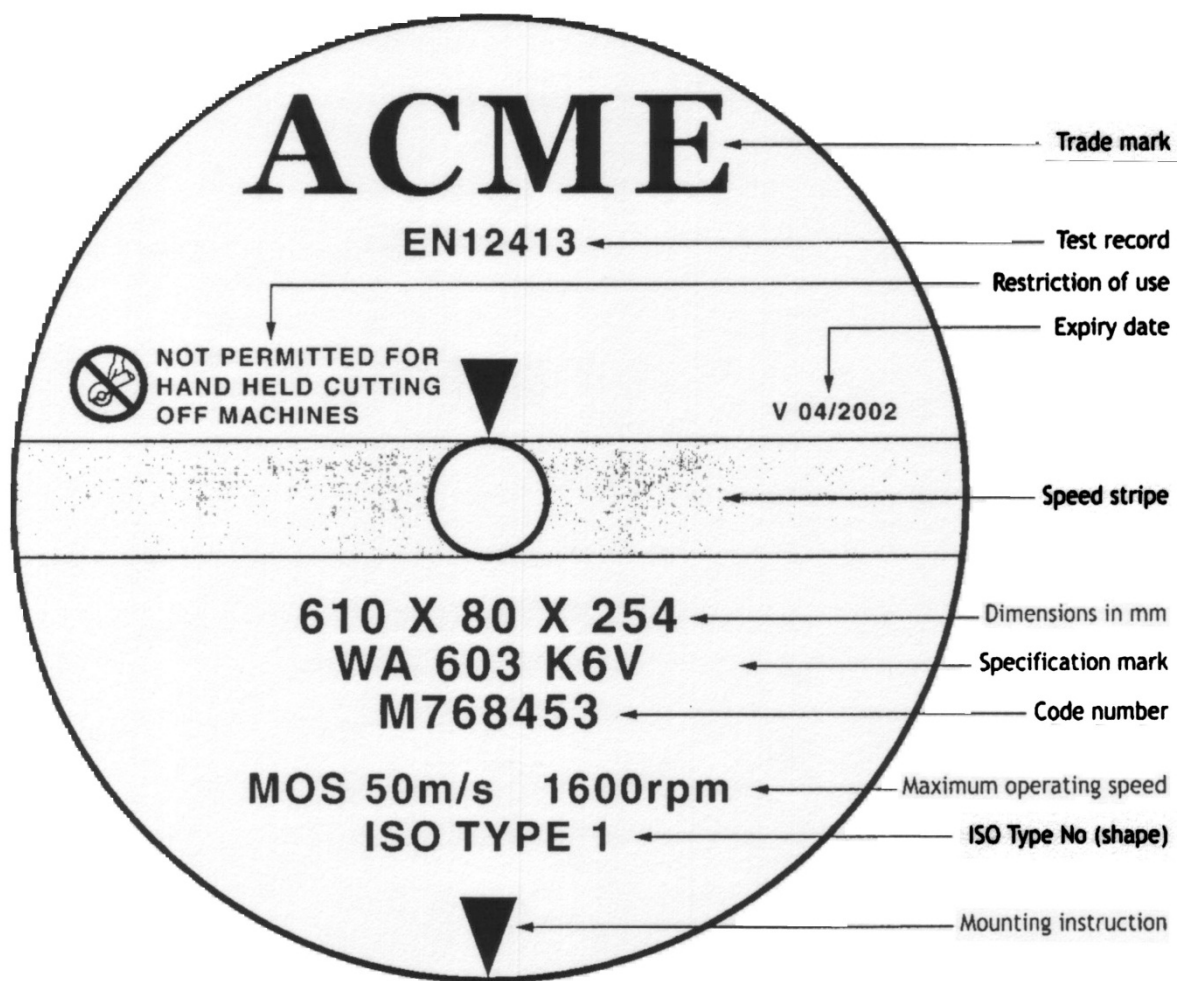
Bond type

This means the bonding material used in the wheel construction.

LABELLING OF ABRASIVE WHEELS

The label on the abrasive wheel contains the above information. In the case of wheels 55mm and less in diameter the information is to be given on a record kept with the grinding machine into which they are to be used. HSG 17 contains the charts used to determine the correct usage for these wheels.

The following sheet shows the meanings of the label found on the abrasive wheel.



EXAMPLE OF ABRASIVE WHEEL LABELING



Key Point

You must be able to read the speed rating of the wheel. If you are not able to do so the wheel **MUST NOT** be mounted

Standard Marking System for Grinding Wheels

(In accordance with the British Standard for Grinding Wheels)

Example as preceding Wheel **A30S4BF**

Abrasive Type	Grit Size	Grade	Structure	Bond	Optional Bond Suffix
---------------	-----------	-------	-----------	------	----------------------

A

30

S

4

BF

A	Regular Aluminium oxide	Coarse	Soft	Close	V – Vitrified	F8, FBLU 10W, 15, 25 30W, 110, 120
AA	White Aluminium Oxide	12 14 16 20 24	F G H J K	2 4 5 6 7	B – Resinoid	M4, RU, DW YZ
3AA	Pale Grey Aluminium Oxide	Medium	L M N	8 9 10	BF – Resinoid Reinforced	E-M, W, 16, 60
BA	Blue aluminium Oxide	36 46 46/54 54	O P Q	11 12 13	R – Rubber	CS, C1, G, T1
DA	Regular/White Aluminium Oxide Mixed	60 Fine	R S T U	14 15 16 Open	E - Shellac	A, AC
PA	Pink Aluminium Oxide	120 180	Hard			
RA		Very Fine				
C	Black Silicon Carbide	220 240 280				
GC	Green Silicon Carbide	320 400 500				
RC	Black/Green Silicon Carbide Mixed	600				
CA	Mixture of Silicon Carbide and Aluminium Oxide					
KA						

SAFETY WITH ABRASIVE WHEELS INCLUDING TESTING

To ensure safe use the abrasive wheel must be stored, handled and mounted correctly. Incorrect storage, handling or mounting can cause wheels to burst.

RESINOID BOND – AS USED ON ALL ANGLE GRINDERS & CUT OFF SAWS

To ensure safe use the abrasive wheel must be stored, handled and mounted correctly. Flat and Depressed Centre type wheels should be stored in cool dry place and not allowed to become frost damaged or wet. Flat wheels are stored flat and stacked one on top of another, depressed centre wheels are stored stacked flat one on top of another. Prior to use they must be visually inspected.

Visual Inspection

The wheel should be visually inspected for damage on the periphery, the bore and the surface. The wheel should be free from cracks, large chips and patches indicating liquid contamination which may affect the wheel balance.



Key Point

**A Resinoid Bond Abrasive Wheel
can only be visually inspected**

Use

The abrasive wheel must be used for the purpose for which it was designed. Do not use a wheel designed for cutting to grind, it is not made to withstand the loads involved and may break. A wheel designed for grinding is thicker and is made to work with the loads imposed by grinding.

Ensure you mount the grinding wheel with the flanges the correct way round for the type of wheel mounted.

Use only the type of wheel designed to be used with the machine in question. Generally an angle grinder utilises a depressed centre wheel and a cut off saw (“Chopsaw”) uses a flat wheel. The exception to this is where thin abrasive wheels are used for cutting particular types of material in either angle grinders or in cut off saws where the material is too thin for a depression to be safely formed.

Speed

The abrasive wheel must have a speed rating equal to or greater than the machine in which it is to be used.



Key Point

The abrasive wheel MUST have a speed rating equal to or greater than the machine on which it is to be mounted

CHANGING ABRASIVE WHEELS; SAFE SYSTEMS OF WORK

When changing an abrasive wheel it must be done to a safe system of work. The following pages detail safe systems of work for changing the abrasive wheels on Angle Grinders and Cut Off Saws.

These Safe Systems of work must be followed for your safety when changing an Abrasive Wheel.



Key Point

**YOU MUST FOLLOW THE SAFE
SYSTEM OF WORK SEQUENCE.
THIS IS FOR YOUR SAFETY AND
THE SAFETY OF OTHERS.**

CHANGING A WHEEL - FLAT & DEPRESSED CENTRE – ANGLE GRINDER

Step 1

Turn off at machine switch.

Step 2

Unplug.

Step 3

Remove old wheel with correct tool.

Step 4

Inspect new wheel.

Step 5

Clean guard, spindle and flanges.

Step 6

Inspect guard, spindle and flanges.

Step 7

Check wheel RPM against machine RPM.

Step 8

Inspect new wheel.

Step 9

Fit new wheel with correct tool.

Step 10

Tighten hand tight.

Step 11

Check the condition of the machine.

Step 12

Adjust guard if required.

Step 13

Plug in.

Step 14

Start machine with no one in its line of motion.

Step 15

Machine now ready to use with new Abrasive Wheel.

Step 16

Put on PPE and start work.

CHANGING FLAT WHEEL ON CUT OFF SAW

Step 1

Turn off at machine switch.

Step 2

Unplug.

Step 3

Remove old wheel with correct tool. The guard needs to be raised to access the retaining screw

Step 4

Inspect new wheel.

Step 5

Clean guard, spindle and flanges.

Step 6

Inspect guard for freedom of movement, spindle and flanges.

Step 7

Check wheel RPM against machine RPM.

Step 8

Fit new Wheel – Hand tighten the set screw with the correct spanner or Allen key remembering to replace the washer if present.

Step 9

Allow guard to return into place.

Step 10

Check the condition of the machine.

Step 11

Lower the machine checking the guard moves freely both up and down as you lower and raise the machine

Step 12

Plug in.

Machine now ready to use with new Abrasive Wheel.

Step 13

Put on PPE and start work.

USE OF ANGLE GRINDER

The Angle Grinder is available in different sizes ranging from small ones at 100mm diameter to larger machines at 230mm. The machine is hand held by the user using the handle by the trigger and an additional handle which is usually able to be moved to different positions to suit the user and the work being done. The safe use of a hand held Angle Grinder in no small part relies on the operator being physically able to control the machine in use. The larger machines are heavy and cumbersome and require physical strength to use. ALWAYS select a machine that is within your physical capability to use. NEVER pull a jammed wheel free with the machine still plugged in.



Key Point

Hot Work Permits are required when using angle grinders. An appropriate fire extinguisher should be to hand

Angle Grinders have guards which can be rotated relative to the handles. It is important that these are correctly adjusted as they are necessary to deflect the sparks produced when in use away from you, the operator. These machines are normally used in many positions not just in a straight line and the sparks emitted can go in any direction. All combustible materials must be removed from anywhere that these sparks may go. In practice it would be prudent to have all combustible materials removed from a radius of 3 metres in any direction. Protect any fixtures or fittings which could be damaged by the sparks with a fire retardant material or one which will not readily ignite if hit by the sparks.

Angle Grinders are hand held and expose the user to risks from Hand Arm Vibration. All Angle Grinders have a unique value expressed in m/s (metres per second) which can be found in the Manufacturer's handbook or if this is lost the information may be found on line. This value is used in a tool to be found on the HSE website to allow the times to be calculated for the safe use of the Angle Grinder in question. A sample Vibration Risk Assessment is shown following.







Key Point

Move all flammable or combustible materials out of the way of the sparks. Wear heavy cotton overalls with no contamination by oils, grease etc.

Ensure that when in use you are wearing the correct Personal Protective Equipment for the work you are doing. The random nature of the sparks given off are likely to be in your direction at some time during the work so the wearing of overalls which are not likely to catch fire are a necessity, heavy cotton overalls are normally acceptable but these must not be contaminated with oils, grease, paint, or any other flammable substance. An appropriate fire extinguisher must be to hand when using an Angle Grinder and it is normal to use such tools under a Hot Work Permit. In addition to mandatory PPE required for workshops or construction sites, wear the above.



VIBRATION RISK ASSESSMENT

NUMBER	8	TOOL	VIBRATION RATING
DATE	01/05/10	Bosch Grinder 21-180/230(J)H 24-180/230(J)B 24-180/230(J)H 26-180/230(J)B 26-180/230(J)H	5.5 m/s
REVIEW DATE	01/05/11		
ASSESSOR	C. N. PERRY		
EXPOSURE ACTION VALUE	1 HR 39 M	EXPOSURE CALCULATION <div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Vibration Magnitude 5.5 </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Time Tool Used For Hours Minutes 8 0 </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Time to reach EAV Hours Minutes 1 39 </div> <div style="border: 1px solid black; padding: 5px; text-align: center;"> Time to reach ELV Hours Minutes 6 37 </div> </div>	
EXPOSURE LIMIT VALUE	6HR 37 MIN		
PERSONS AT RISK			
OPERATIVES			
CONTROLS: TO BE IMPLEMENTED BY OPERATIVE & SUPERVISOR. MONITORING OF COMPLIANCE BY SUPERVISOR			
 Wear gloves when using this machinery	WEAR GLOVES. GLOVES KEEP YOUR HANDS WARM AND PROMOTE GOOD CIRCULATION IN YOUR HANDS		
 NO SMOKING	DO NOT SMOKE. SMOKING TENDS TO PROMOTE CARDIOVASCULAR DISEASE AND POOR CIRCULATION.		
 Caution	DO NOT USE THE TOOL FOR MORE THAN THE TIMES GIVEN BELOW HEALTH SURVEILLANCE MUST BE IN PLACE FOR USE ABOVE THE ACTION VALUE.		
TIME TO ACTION VALUE	USE UP TO	TIME TO LIMIT VALUE	NO MORE THAN
	1hr 39min	 HEALTH SURVEILLANCE REQUIRED !!	6hr 37min

NOTES ON SAFETY

NO PERSON SHALL MOUNT AN ABRASIVE WHEEL UNLESS THEY HAVE BEEN TRAINED UNDER THE PROVISIONS OF THE POWER REGULATIONS AND THE GUIDANCE CONTAINED IN HSG 17.

ALWAYS

1. Do always store and handle wheels in a safe manner.
2. Do visually inspect all wheels prior to mounting to ensure they are free from damage.
3. Do always only use a reinforced wheel
4. Do make sure that the operating speed of the machine does not exceed the speed marked on the wheel.
5. Do ensure you have the flanges the correct way round for the wheel, remember that a cut off wheel is not as thick as a grinding wheel and the outer flange must be the correct way round for the wheel
6. Do be sure that the guard is correctly adjusted for the work to be done
7. Do always allow newly mounted wheels to run at operating speed held clear and away from yourself or others before using them
8. Do always use appropriate eye protection suitable for the task.
9. Do always wear a dust mask when grinding for prolonged periods or when there is a likelihood of creating dust.
10. Do always wear gloves
11. Do always wear ear defenders

NEVER

1. Do not use a wheel which has been dropped.
2. Do not force a wheel onto the machine spindle or modify the size of the mounting hole.
3. NEVER exceed the maximum operating speed of the wheel.
4. Do not use mounting flanges on which the bearing surfaces are not clean and flat.
5. Do not tighten the mounting nuts excessively.
6. Do not start the machine with the guard not in place.
7. Do not grind material for which the wheel is not designed.
8. Do not grind with a cut off wheel.

USE OF CUT OFF SAW

A Cut Off Saw is usually used to cut down long lengths of material to shorter lengths of the required size for installation.

The machine has a clamp to secure the material to be cut, a sliding guard to cover as much of the abrasive wheel as possible during operation. Some are fitted with a spark deflector to minimise the sparks which remain in the direction of the operator.



The photograph shows the clamp to secure the material and the guard in its position ready for use. The photograph below shows the side view and the section of the guard which moves as the cut is made.



These machines should be set up with adequate space for the length of the material to be cut and with all combustible materials removed from around 1.5 metres to the sides, 3 metres in front and 1.5 metres behind, as shown below.

Ensure that when in use you are wearing the correct Personal Protective Equipment for the work you are doing. The nature of the sparks given off in your direction require you to wear overalls which are not likely to catch fire, heavy cotton overalls are normally acceptable but these must not be contaminated with oils, grease, paint, or any other flammable substance. An appropriate fire extinguisher must be to hand when using a Cut Off Saw and it is normal to use such tools under a Hot Work Permit.

A dust mask may be required depending on what you are grinding and the duration of the task

In addition to an mandatory PPE required for workshops or construction sites



NOTES ON SAFETY

NO PERSON SHALL MOUNT AN ABRASIVE WHEEL UNLESS THEY HAVE BEEN TRAINED UNDER THE PROVISIONS OF THE POWER REGULATIONS AND THE GUIDANCE CONTAINED IN HSG 17.

ALWAYS

1. Do always store and handle wheels in a safe manner.
2. Do visually inspect all wheels prior to mounting to ensure they are free from damage.
3. Do make sure that the operating speed of the machine does not exceed the speed marked on the wheel.
4. Do only use a reinforced wheel
5. Do be sure that the guard works correctly and moves freely up and down
6. Do always allow newly mounted wheels to run at operating speed before using them
7. Do always use appropriate eye protection suitable for the task.
8. Do always wear a dust mask when grinding for prolonged periods or when there is a likelihood of creating dust.
9. Do always wear ear defenders

NEVER

1. Do not use a wheel which has been dropped.
2. Do not force a wheel onto the machine spindle or modify the size of the mounting hole.
3. NEVER exceed the maximum operating speed of the wheel.
4. Do not use mounting flanges on which the bearing surfaces are not clean and flat.
5. Do not tighten the mounting set screw excessively.
6. Do not use the machine with the guard not in place or defective
7. Do not grind material for which the wheel is not designed.