Retrofitting woodworking machine brakes

HSE information sheet

Woodworking Information Sheet No 38 (Revision 1)

Introduction

This information sheet provides advice on how to interpret and apply the requirements of regulation 15 of the Provision and Use of Work Equipment Regulations 1998 (PUWER 98)[1] and paragraphs 130 to 135 of the Approved Code of Practice (ACOP) *Safe use of woodworking machinery*.[2] These relate to the retrospective fitting of braking to certain classes of woodworking machinery.

It is aimed at employers and operators, although the advice will also be of use to those who supply woodworking machinery, see 'Further reading'.

Why do I need to fit braking to my machinery?

New woodworking machines should all come fitted with some form of braking where necessary. Machinery must be equipped with an automatic brake that stops the tool in a sufficiently short time (defined in European Standards as ten seconds or less) if there is a risk of contact with the tool while it runs down.

Because of the safety benefits that braking provides, HSE's position is that this standard should also apply to machines already in use. Regulation 15 of PUWER 98 requires work equipment to be provided with controls which bring the work equipment 'to a safe condition in a safe manner'. To achieve this, the ACOP calls for employers to carry out a risk assessment to determine whether the retrofitting of braking to their machines is necessary. It also includes a list of machines in paragraphs 131 and 132 where braking will be required.

If the decision whether or not to fit braking is based on risk assessment, why are some machines listed in the ACOP?

The machines listed are primarily the hand-fed machines that are in common use. For these machines, the accident record suggests that braking should be fitted. So, in most cases, it is expected that your assessment will show braking to be necessary if there is a risk of contact with the tool while it runs down. Some classes of woodworking machine have a number of variants and so, if a particular machine is not listed, it is no excuse for not fitting braking. This is because machines with broadly similar functions and operations will have similar hazards and are therefore likely to pose similar risks when used.

Which machines should be braked?

The ACOP gives a timetable for certain specified classes of machine where braking is considered to be necessary.

Machines to be braked by **5 December 2003**:

- Circular saw benches.
- Dimension saws.
- Powered and hand-fed cross-cut saws.
- Single-end and double-end tenoning machines and combined machines incorporating a circular saw and/or a tenoning attachment.

Machines to be braked by **5 December 2005**:

- Narrow bandsaws.
- Re-saws.
- Vertical spindle moulding machines (unless fitted with a manual or foot-operated brake).
- Hand-fed routing machines.
- Thicknessing machines.
- Planing/thicknessing machines.
- Surface planing machines.

Machines to be braked by **5 December 2008**:

- All machines not specified in the previous lists and where risk assessment shows braking to be necessary.

Note: The phasing in of these requirements was designed to spread the burden, financial and otherwise, of the work that needed to be done.

If my risk assessment shows that I need braking, what are my options?

Unless there is technical expertise available in-house, **you should get advice from the manufacturer of the machine**. If this is not possible, then you should get specialist engineering advice, for example from reputable suppliers of second-hand woodworking machinery.

The main ways of providing braking are to:

- replace the existing unbraked motor with a braked motor;
- use an electrical braking solution by fitting a variable speed drive (VSD), or a direct current (DC) injection braking device to the existing unbraked motor;
- fit a power-operated mechanical brake;
- fit a manual or foot-operated brake.

You can apply these methods singly or in combination, but when selecting the most appropriate you should take a number of factors into account.

Replacing an unbraked motor with a braked motor

When considering this method, the factors to take into account are:

Space

- Where motors are mounted inside the machine frame, space is more likely to be a problem as braked motors are invariably longer than the unbraked equivalent. There is less likely to be a problem where the motor is mounted externally.

Ease of replacement

- Many motors, particularly on older machines, were purpose-built and incorporated non-standard motor casings and attachment points. In these cases, it will probably not be possible to obtain a braked replacement motor to fit the existing mounting points. Either modify the machine frame to accept the braked motor, if possible, or find an alternative solution.

Suitability

- Replacing an unbraked motor with a braked motor is not suitable for band re-saws due to the large amount of stored energy, including heat, which needs to be dissipated on stopping.

Fitting a variable speed drive

Variable speed drives (VSDs) are sometimes referred to as converters, inverters, or variable frequency drives. They are designed to control the speed of a three-phase motor by varying both the voltage and frequency of the current. In addition to braking, motor speed control can also be used to:

- reduce resonance of the tooling or workpiece;
- reduce the need for changing speeds by belt changing etc to achieve an optimum cutting rate.

When considering this method, the factors to take into account are:

Starter type

- A VSD will replace the existing motor starter. However, to ensure that the integrity of any emergency stop functions of a machine remain unchanged, it may be necessary to retain a motor contactor to ensure that the electrical supply can be switched off completely. This is because inverters are electronic devices and cannot be relied upon when switching the machine off for safety reasons, unless specifically designed for that purpose. However, it will be necessary to ensure that the contactor is operated only after the motor has stopped, otherwise the braking effects of the VSD will be lost. If using just an inverter drive it is even more important to isolate the machine correctly before undertaking any work on the rotating parts. Do not rely on the stop function alone. Safe electrical isolation is the most reliable way of preventing an unexpected start-up, provided that there are suitable means to ensure accidental reconnection is prevented – for example, breaking the 3-phase by mechanical means and a locking-off facility.
- A VSD can allow the direction of rotation to be reversed. Where this is undesirable – such as on circular saws, where reversal can lead to loosening of the blade-retaining nut – it is important to select a VSD that can have reversing disabled.

Motor type

- VSDs can only be used for three-phase motors so you will need to replace any single-phase motors before using this option.

Power supply

- VSDs can be used with a single- or three-phase power supply, as inverters are available for use with both types of supply.
- Starting surges will be reduced compared to a direct on-line (DOL) starter.
- Some braking will still be available once power has been lost as VSDs have sufficient stored energy to ‘ride through’ any momentary fluctuations of the mains supply. This comes from the stored power within the capacitors on the DC system, plus the internal energy of the load.
- VSDs can also be set to initiate braking, using the stored energy as well as the energy produced by regenerative braking. Regenerative braking feeds

energy back from the machine into the inverter and, if the machine loads have a high inertia, braking resistors may be required to dissipate the energy to prevent the inverter tripping on high voltage. This is only likely to be an issue on very large machines and where there is rapid deceleration. However, in such cases, if resistors are not fitted, the inverter drive is likely to trip during braking and result in the machine coasting to a halt. The braking effort can therefore remove most of the rotational speed from a motor even when there is no power supply.

Stopping time

- The stopping time, and sometimes the speed curve, can be set on VSDs, so that the stopping time is smooth and constant for a range of loads. In general, however long it takes to accelerate the load will be nearly matched by the stopping time.
- The acceleration can also be progressive, which can reduce the mechanical demands on the machine, eg where turning unbalanced workpieces on a lathe.

Effect on the motor

- VSDs do not submit the motor and the machine to the shock that is produced by other braking. However, if the VSD is used to run the motor at a low speed for long periods, you need to take care that the reduced effect of the cooling fan does not lead to overheating.
- Some care is needed as inverter drives can cause premature failure of the winding insulation of very old electric motors.

Fitting a DC injection braking device to an existing unbraked motor

When considering this method, the factors to take into account are:

Motor type

- DC braking is not suitable for some types of motor, eg slip ring motors. (These are typically the larger motors of 10 horsepower or greater.) You should consult the motor manufacturer before braking is fitted.

Power supply

- Braking is only available when there is power to the machine, so a loss of power would leave the machine unbraked. It is therefore not suitable in workshops where there is a history of power supply instability.
- Some educational establishments such as schools/colleges etc often have an emergency stop system in place. In these cases, DC braking units will work only where there is a back-up supply.

Stopping time

- A range of stopping times are possible with DC braking. Stopping can be very rapid, which can create problems – eg the blade can come undone with some circular saws. It is recommended that saws over 25 cm in diameter are retained by pinning them to the drive shaft, or by lock nuts.

Failure of the motor

- Older motors may fail due to the increased mechanical forces caused by the injection of DC into the windings. The motor would then need to be rewound but, if properly done, with due consideration of new operating requirements, the problem should not recur.

Fitting a power-operated mechanical brake

The main considerations here are the safety, integrity and reliability of the braking system. Ideally, the brake should be applied and held on by means of a spring and require electrical power to release it, although other systems using pneumatic or hydraulic power are also available. Mechanical braking is most efficient when applied to the low torque end of the drive unit.

Fitting a manual or foot-operated brake

This is always an option and this type of braking is already provided on many older machines. The primary consideration is meeting the stopping criteria. Safety is enhanced if the brake is activated by some form of actuator, eg a pneumatically or electronically operated solenoid.

Does a machine always have to stop within ten seconds?

The ACOP says that ‘braking devices are not considered necessary when machines have a run-down time of ten seconds or less’. However, this does not mean that braking must always stop the machine within that time.

While it is possible to fit some form of braking to any woodworking machine, for some machines, bringing them to rest within ten seconds might be positively harmful to the machine and dangerous to the operator or others close by. This is the case where:

- large amounts of energy have to be dissipated during braking (see the earlier example of the band re-saw);
- there is a danger of blades breaking, for example as a result of a crack, as may be the case on any machine fitted with a band blade.

The overriding consideration should be to bring the machine to a safe stop. The run-down time should be less than the run-up time, with an overriding maximum of 35 seconds for some larger machines (30 seconds for bandsaws).

Are there any circumstances when braking does not have to be fitted?

If your risk assessment shows that there is no added safety benefit, then braking does not have to be provided. One example would be where interlocked guards – incorporating guard locking so guards cannot be opened until cutters have come to rest – enclose the cutters. Alternatively, the whole machine might be enclosed, eg by a noise hood, but the same interlocking requirements as above will apply.

Another example is where the blade, tool or cutter returns automatically to a position of safety, such as a cross-cut saw fitted with a spring return which retracts the blade into a protective housing at the conclusion of the cut. In these situations, the time taken for the machine to run down does not matter. This is because an acceptable standard of safety has already been achieved by guarding and there is no risk of contact with the tool while it is running down. It is, however, important to make sure that any return device is properly maintained.

You should remember that, as well as improving safety, braking can also improve productivity, since more rapid stopping is an aid to quicker setting, adjustment and unjamming of a machine.

There are some occasions when it might be necessary to temporarily disable the braking system. These include tracking a band re-saw and setting up a double-end tenoning machine or an edge banding machine. In these situations, it is essential that:

- the controls for starting are only operable in the hold-to-run mode;
- the disablement function is automatically overridden and braking is applied if any guard is opened, or if the emergency stop control is operated.

References

1 *Safe use of work equipment. Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance* L22 (Third edition) HSE Books 2008 ISBN 978 0 7176 6295 1
www.hse.gov.uk/pubns/books/l22.htm

2 *Safe use of woodworking machinery. Provision and Use of Work Equipment Regulations 1998 as applied to woodworking machinery. Approved Code of Practice and guidance* L114 HSE Books 1998
ISBN 978 0 7176 1630 5
www.hse.gov.uk/pubns/books/l114.htm

Further reading

Further information on braking is available on HSE's woodworking website:
www.hse.gov.uk/woodworking/faq-braking.htm

Information on new and second hand machinery and for suppliers, importers or hirers of equipment can be found on HSE's Work equipment and machinery website: www.hse.gov.uk/work-equipment-machinery/supplier.htm

Further information

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk/. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

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