Guidance on the safe use of magnetic lifting devices

Introduction

1 This document provides advice about reducing the risk of both injury to operators and other people, and of damage to plant and equipment from the use of magnetic lifting devices. The guidance was previously contained in HSE Operational Circular 234/16 and the associated Information Document (aimed at users of this equipment). It describes the hazards involved and some of the precautions that need to be considered when planning and carrying out handling activities using magnetic lifting devices.

2 The main concerns relate to electrically powered magnets used for lifting operations, but some of the issues will be equally applicable to permanent magnets.

3 This guidance has been prepared in consultation with the Steel Stockholding Lead Authority Partnership (a tri-partite body comprising Wolverhampton City Council, the National Association of Steel Service Centres (NASS) and the Health and Safety Executive), UK Steel, the British Recycled Metals Association and the Lifting Equipment Engineers Association.

The equipment

4 Electrically operated magnetic lifting devices, in the form of a single magnet or a group of magnets suspended from chains or wires or attached to lifting equipment in another way, can be used for lifting and transporting steels and most ferrous materials or components without the need for slingers. They are widely used in many industrial sectors including metal/component manufacture and storage, shipbuilding, and metal recycling facilities.

5 Magnets can be provided without power supply i.e. permanent magnets, or where power is supplied from an external source or through an in-built battery. Electro-permanent magnets are also available where permanent magnets are utilised to hold the load and power is used to release the load. Power is used to both energise and release the load. They use a combination of permanent magnets and magnets whose polarity is switched by an electrical pulse rather than mechanically. Some can be

partially energised to facilitate load shredding. Different shapes and types of magnet are available, for example:

- flat pole plate magnets for handling sheet metals and bulk goods such as scrap iron, etc;
- specially-shaped pole plate magnets for lifting pipes, round steel bars or sectional steel;
- magnets with adjustable pole fingers for lifting items of irregular shape;

Main hazards

6 The principal safety hazard associated with their use is from falling material. People, plant, equipment, and services in the area of operation could be at risk from being struck by material which becomes detached from the magnet e.g. due to failure of the lifting device following loss of power, or due to incorrect application or operation.

7 A potential health risk to people working in the vicinity of these magnetic lifting devices is from the electromagnetic field (EMF) around the magnet (or around the supply conductors should the currents be very large). It is thought that this may interfere with the operation of implanted active body implants, such as heart pacemakers or insulin pumps (See paragraph 25). EMFs can also interfere with communication and control systems/equipment which could be safety related and therefore, create consequent risks which should also be assessed.

Legal requirements

8 Under the Lifting Operations and Lifting Equipment Regulations 1998 (LOLER), magnetic lifting devices that are an integral part of machinery are classed as '*lifting equipment*'; those that can be fitted to, and taken off, lifting equipment are considered to be '*accessories for lifting*'. '*Lifting equipment*' and '*accessories for lifting*' are both '*work equipment*' within the meaning of the Provision and Use of Work Equipment Regulations 1998 (PUWER).

9 The key requirements under LOLER and PUWER are set out in HSE guidance (see Further Reading) and on the HSE webpages Work equipment and machinery. Additionally, the Safety Assessment Federation (SAFed) publish guidelines on what their assessment engineers look for during the *thorough examination and test* as required by LOLER. The relevant guide for electrically operated magnetic lifting devices (ref MLCC08) can be downloaded from SAFed's website at Machinery Lift and Crane Guidelines.

10 Magnetic lifting equipment supplied (or put into service) for the first time in the EU should meet the requirements of the Supply of Machinery (Safety) Regulations 2008. Further information is set out in HSE guidance at Work equipment and machinery. The current harmonised European Standard for magnetic lifting devices is BS EN 13155:2003+A2:2009 *Cranes - Safety – Non-fixed load lifting attachments*.

11 Suppliers of second-hand work equipment have duties under Section 6 of the Health and Safety at Work etc Act and further guidance is available on the HSE webpages Second-hand (re-supplied) products - Work equipment and machinery

Precautions

General

12 Equipment suppliers should provide suitable technical information, particularly about the strengths and distribution of magnetic fields around the magnet for typical load configurations, so that users may complete appropriate risk assessments for its use and maintenance. Where an external electrical power supply is required suppliers should provide information on power requirements.

13 Before recommending or supplying magnetic lifting equipment, suppliers should:

- Obtain sufficient information from the prospective user to ensure the equipment supplied will be safe for its intended use e.g. mass, shape, dimensions, structural stiffness, magnetic properties of the load;
- Provide adequate information about the use for which the equipment was designed and tested;
- Advise prospective users about risks of direct or indirect effects on their employees and other people present on site (eg haulage drivers).
- Provide adequate information on any potential electromagnetic compatibility issues.

14 Magnetic lifting devices should not be treated as 'general purpose' pieces of lifting gear as they have to be designed to suit particular types of loads and environments. Users should seek advice from the equipment manufacturer on the suitability of an existing device for all new applications.

15 Consider (as part of your risk assessment) installing permanent magnets with electromagnetic release so that in the event of a power failure, battery backup will not be needed.

Safety measures

16 The following safety measures should be considered [where equipment which is not to the current BS EN 13155:2003+A2:2009] and provided where reasonably practicable -

- Warning devices **-** equipment for lifting should be fitted with suitable warning devices and indicators to show when it is magnetised or operating at a reduced power level
- Protection against failure of electrical supply - Except for the permanent or electro-permanent magnet types, any interruption to the electrical supply could result in a release of the load. Consequently for battery-fed devices with a safe working load (SWL) of greater than 20 kg
    - An automatic warning should be provided which monitors the power supply and provides a warning at least 10 minutes before the supply reaches the level where the load will be released. The warning device should be optical or acoustic.
    - After the automatic warning device has been activated and the magnet has been switched off, the magnet should be prevented from being switched on again until the battery is recharged to a greater level at which the automatic warning device is activated.

  For external electrical supply devices with a SWL of greater than 20 kg
    - An automatic warning device should be provided to warn if the external power supply fails. The warning may be optical or acoustic.
    - A stand-by battery should be provided to automatically supply power when the external supply fails. It should be capable of providing the current needed to hold the SWL for at least 10 minutes.

    - Where magnets are to be used in areas in close proximity to persons, redundancy should be provided by duplication of power cables, connections and power controller. Alternatively a secondary positive holding device should be provided.
- Protection against inadvertent operation of the controls - Releasing the load should require two control actions.

Risk assessment

17 Employers should carry out a suitable and sufficient assessment of the risks, before new or existing magnetic lifting devices are specified for handling loads. This should consider whether such devices are appropriate and suitable taking into account all the circumstances of the proposed operation. Additionally, the proximity of persons to magnet should be considered (for all risks) and whether it is foreseeable that persons may deliberately or inadvertently approach the magnet. The assessment should be carried out by someone with knowledge of the material storage and handling processes, as well as the capabilities and limitations of this type of lifting equipment. Employees and their safety representatives with first-hand knowledge of the hazards and risks involved should be consulted during risk assessment.

18 Some of the factors that have a bearing on the selection of lifting magnets and operating conditions, particularly the SWL, include:

- **Magnetic properties of the load** - Magnet lifting is not appropriate for all steels. For example, some stainless steels are not magnetic and other types are only partially magnetic. When handling mixed steel types, it should be recognised that non/partially magnetic items are likely to fall away if magnetised pieces supporting them move.
- **Load weight, thickness, shape and area in contact with magnet** - The surface area of the load and the proportion of the magnet face in contact with it will dictate the number and size of magnets required for safe handling almost as much as the weight and thickness of the load. For example, a billet may only require a single two-pole magnet, whereas a thin plate section of equal weight may require a multiple arrangement of magnets.
- **Surface profile of materials to be lifted** - Where the surface is non-uniform e.g. corrugated, embossed or perforated sheet, flat lifting magnets can be used but must be rated according to the percentage of the load which actually contacts the magnet face.
- **Composition of the load** – A porous load or a load with an internal void may not adhere as well as a solid load.
- **Lifting of multiple loads (stockholding)** - Multiple loads can include several sheets or plates. Power (i.e. flux) reduction can be used to shed the excess load, and the full power then restored to secure the remaining load.
- **Lifting of multiple loads (scrap)** - Where magnets are used to lift many and varying pieces at the same time, for example when handling scrap, penetration of the load by the magnetic flux may be poor at the periphery of the load and part of it may fall off, even though the nominal SWL has not been exceeded.
- **Stiffness or flexibility of the load** - Droop or overhang at the ends of a flexible load e.g. long bar, flat or thin sheet, may cause it to peel off the magnet under its own weight during handling operations. A number of magnets may be selected to give greater coverage over the load area

rather than reliance being placed on weight-lifting ability alone. Proper configuration/positioning of the magnets should minimise the sag or droop of the overhanging portions of a load.

- **Range of sizes to be lifted and frequency of operations** - Where assemblies of magnets are likely to be required to handle a range of load shapes and sizes, it is essential that the equipment supplier and/or the person carrying out the risk assessment are provided with sufficient information about the likely demands on equipment. This should help them determine if magnetic lifting is feasible and safe and, if so, how the system should be configured to ensure it is safe for use.
- **Nature of the lifting operation** – If the load is not balanced and hanging level, or the operation requires the load to be tilted, slippage may occur unless the adhesive force generates sufficient friction to resist it.
- **Surface condition of load and magnet -** The effectiveness of a magnet falls rapidly as the distance between its face and the load i.e. the air-gap, is increased. Good contact between the surfaces of the magnet and the load is essential for the magnet to achieve optimum and safe performance. To maximise contact, both the magnet face and the load surface should be as smooth and clean as possible and the air-gap kept to a minimum. The surface texture or finish of the load and the presence of paint, rust, oxide scale, oil, ice and snow etc and non-magnetic material on either surface will increase the air-gap, thus reducing the contact and, possibly, the magnetic effectiveness.
- **Temperature of load and magnet** - The temperature of the magnet and load should be taken into account as, for example, ferrous materials lose their magnetic properties with increasing temperature and cease to be magnetic at around 700^{o}C. Magnets should not be used for hot work unless specially designed for this duty, and then only within the specified operating temperature limits.
- **Capacity of any external electrical power supply** - Where an external electrical power supply is required it is important that it has sufficient capacity to supply the magnetic attachment. On mobile lifting equipment it is important that the generator or alternator is of sufficient capacity. Any cables and electrical connections between the power source and magnet should be correctly sized.

19 Other issues that should be taken into account in the risk assessment include:

- **Rating of lifting equipment** - the weight of the magnet and its accessories should be taken into account when assessing the load carrying capacity and safe operation of that lifting equipment.
- **Protection against lifting excess material** - When lifting plates etc from a stack, the magnetic field can be such that more material than required is magnetised, with those items furthest from the magnet liable to be easily displaced. A reduced-power or similar facility can be used to avoid lifting excess material. Restoring the full power secures the remaining load.
- **Magnetic lifting devices attached to mobile cranes** - Mobile cranes have to contend with the weight of the magnet and also the inertia effects during slewing and travel. Consideration also needs to be given to the effect if the load were to be suddenly released before it has been grounded. Guidance should be sought from the mobile crane manufacturer when the use of a magnetic lifting attachment is being considered. The manufacturer may advise against using a magnetic attachment or require de-rating the normal SWL when using magnets.

- **Lifting of bundles** - Where magnetic lifting devices are used to handle bundled materials, it is essential that appropriate risk control measures are in place to protect people, plant and equipment from the risk of falling material. In particular:
    - The magnetic equipment used must be suited to the task; and
    - Magnetic lifting devices should not be used to lift bundles of materials unless the banding is rated for lifting duties (i.e. it is marked with a SWL). Standard banding wire/straps used to restrain loads during transit should not be relied upon for lifting duties.
    - All persons should be prevented from entering any area where they could be injured if a bundle broke apart during lifting/handling.

Safe Operating Procedures

20 Safe operating procedures should be prepared and kept readily available for each magnet lifting arrangement. In addition, tables detailing the maximum loads for each type of material e.g. plate, bar, tube, casting etc, the range of thickness of the materials, and different air gaps should be conveniently displayed.

21 The following safe working practices should be considered for inclusion in any operating procedures for the safe use of magnetic lifting devices, though some of them may be inappropriate for handling waste materials:

- Use the right equipment and be aware of the limitations of each device e.g. 'lift only one piece of material at a time', 'unsuitable for handling waste materials' etc.
- Always follow the manufacturer's instructions.
- Do not use magnetic lifting devices to handle containers of gases or liquids
- Check the thickness of materials before lifting and compare with the tables for lifting capacities for different thickness [SWL's are normally quoted for a specific thickness of material]
- Ensure that magnetic lifting devices are inspected for damage before each use (see maintenance and inspection section below)
- Ensure that there is good contact between the surfaces of the magnet and the load. Magnetic efficiency could be affected by surface contamination.
- Take account of the rigidity of the load e.g. bundle shape and profile. Any lifting beam used must be fit for purpose.
- Where possible, use magnets only for handling single items. Fully assess the risk of items being lifted becoming detached/peeling off, where they are not in direct contact with the magnet i.e. magnetism is transmitted through one or more other items closer to the magnet.
- Do not exceed the SWL. Where more than one magnet is to be used, it is important that the centre of gravity of the load is ascertained so that the load taken by each magnet can be established. It is important that the SWL of each individual magnet is not exceeded.
- Load sensors (load cells) are not currently in common use. However, if multiple magnets are used, consideration should be given to the use of multiple load sensors to warn of the SWL being approached.
- Measures should be in place to ensure that everyone, other that the person using the magnetic lifting device, is kept away from the immediate area whilst lifting magnets are in use. The extents of the area will be dependant on the characteristics of the load, the height and speed the material is to be lifted. Display suitable warning notices at entrances to places where magnetic lifting is taking place. Prevent unauthorised access into 'lifting zones', especially at

automatically controlled processes. When loose scrap material is being lifted all persons should be excluded from the scrap handling area. Provide operators with safe places of work to ensure that they cannot be struck by displaced loads e.g. reinforced crane cabs.

- Do not transport a loaded magnet where there is a risk of injury to any person should the load or part of it fall off. All movement of materials should be properly organised and managed to prevent injuries and damage to plant and key services. Travel routes should be clearly defined and maintained.
- Assess the risks involved before allowing the load to 'jump up' onto the magnet at the start of lifting. This may be a particular problem where loads much larger than the magnet are being lifted. One way to avoid loads jumping onto magnets is to gently lower the de-energised magnet onto the load and, after the power has been switched on, allow it to settle for a few seconds to allow the magnetic field to reach its full strength. (However, in the recycled metals industry it is common practice to use an energised magnet to collect small items that have fallen through the fingers of a mechanical grab eg during a loading operation, by a ‘sweeping action’ at, say, 100mm above the ground, over a wide area causing the items to jump onto the magnet.)
- Transport loaded magnets at the lowest height possible, where practicable no higher than 1.5m above ground level. Where this is not practicable, other precautions should be considered (eg the enforcement of extended ‘exclusion zones’).
- Magnets should also be de-energised (whilst unloaded) before unplugging to prevent an electric arc being drawn across the plug and socket which could lead to danger. You should never leave a load hanging in the air.
- Assess dangers of access to vehicle load areas e.g. to trim the load, where magnet lifts are used for loading lorries.
- Prepare arrangements for dealing with emergencies e.g. action to be taken in the event of power/equipment failure, displaced loads, etc.

Training of employees

22 Magnetic lifting devices should be operated only by trained persons who have been adequately informed, instructed and trained in the safe use of the equipment and the findings of any risk assessment. Training should cover:

- potential dangers from the use of magnetic lifting equipment
- factors, including load configuration, which may cause equipment or lifting operation failure and how to avoid them
- principles for selecting the right equipment
- limitations on the use of the equipment including the ‘de-rating’ of the SWL depending on the thickness and type of material (eg bar, plate) calculated from the lifting tables supplied by the manufacturer
- arrangements for planning and carrying out safe lifting operations, including safe systems of work
- specific instructions on safe use issued by the manufacturer/supplier
- location and operation of the equipment controls
- arrangements for pre-use, in-service inspection and maintenance including reporting of any defects

- scheme for examination, maintenance requirements and system for reporting defects
- emergency arrangements

Equipment inspection, maintenance and thorough examination

23 The manufacturer's instructions for the regular inspection and maintenance of the magnetic equipment should be followed. Where appropriate, inspection and maintenance schedules should include:

- power cables to the magnet - check for damage and ensure that they are properly supported
- magnet assembly - check for damage to the suspension points and that retaining bolts are kept tight
- magnet face – check for any damage to the face which might affect performance
- magnet - check for deterioration of insulation resistance; check the value of coil resistance to ensure that "inter-turn" faults have not developed whilst in use
- electrical plug and socket connectors - check that mechanical strength, insulation and electrical conductivity are being maintained
- lifting accessories e.g. chains, links etc associated with the magnet - thoroughly examine at appropriate intervals
- electrical back-up batteries - check their condition and that the battery back-up alarm works when the power is off.
- control boxes/pendants – check for damage, legibility of control labels, correct function of controls including audible and visible warning devices.
- Magnetic adhesion – periodic verification by inserting a 'test piece' of non-metallic material between the magnet and the material. It should still be possible to pick up the load with the test piece inserted.

Safe working procedures should be devised for the safe isolation of the electrical supply (including any batteries) and followed by appropriate personnel.

24 Magnetic lifting devices should be thoroughly examined by a competent person and if appropriate, inspected at suitable intervals between the thorough examinations. Devices which are considered to be 'lifting equipment' are required to have 12 monthly thorough examinations and those considered 'lifting accessories' every 6 months (see Paragraph 8 for details). An alternative approach is for the competent person to examine the device as part of a written examination scheme.

Electromagnetic fields (EMF)

25 Workers with active body implants (e.g. heart pacemakers or less commonly insulin pumps, defibrillators and nerve stimulators), may be affected by the EMF around magnets. The worker's medical specialist should be able to advise them of any risks associated with the implant. However, following the general rule of keeping people clear of the lifting/transporting zone to protect them from any displaced load (during operation), should also ensure that risks from EMFs are reduced to a minimum. Assessment of exposure during maintenance work may be more complex. BS EN 50527-1:2010 *Procedure for the assessment of the exposure to electromagnetic fields of workers bearing active implantable medical devices – Part 1 – General* and BS EN 50527-2:2011 *Part 2 Specific assessment for workers with cardiac pacemakers* will be helpful in assessing these risks.

26 EMFs may also interfere with other plant/equipment and controls (including safety control systems and communication equipment). The effects of EMFs on such equipment should be assessed especially where this equipment is considered to be safety critical. These effects are more likely if higher currents are used.

Further reading

1 Safe use of lifting equipment LOLER Approved Code of Practice and guidance L113

2 Safe use of work equipment PUWER Approved Code of Practice and guidance L22

3 *Board Statement on restrictions on human exposure to static and time varying electromagnetic fields and radiation* (Docs of the NRPB Vol 4, No 5, 1993 HMSO, ISBN 0 85951 366 1)

4) HSE guidance note HSG246: Safety in the storage and handling of steel and other metal stock

5) BSEN13155:2003+A2:2009 Cranes - Safety – Non-fixed load lifting attachments

6) *Buying new machinery* and *Supplying new machinery*, both free from HSE Books.