HANDLING OF MAGNETS

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OVERVIEW

Magnets, electromagnets & electro-permanent magnets can be dangerous if mishandled through carelessness or lack of knowledge. This document applies to any of these units. Users and handlers of magnets and magnetic assemblies need to be aware that magnets can be dangerous if mishandled. Magnets are not toys.

Magnets are often more powerful than people think and many people are surprised at how strong they actually are for their size.

Take great care when using magnets. Be safe. Do not rush. Never be complacent. Always assume magnets are extremely powerful to start with and you will increase your chances of keeping safe. Protect yourself and everyone who may be near the magnets.

You should always perform a Health and Safety (H&S) risk assessment for everyone who may be using or be near the magnets and wear appropriate PPE (Personal Protective Equipment) as necessary before handling any magnets and, if in doubt, do not use the magnets until you have consulted the magnet supplier for advice.

The user / handler of magnets is responsible for their own safety at all times (we accept no responsibility or liability whatsoever for any accidents or incidents involving magnets).

HANDLING

Magnets can cause serious injury if the necessary safety precautions are not followed.
A lack of concentration is one of the most common causes of injury when handling magnets.

Magnets will attract to each other and also to ferrous/ferritic materials (such as mild steel).
The size, shape, grade/material and magnetic design of the magnet or magnetic assembly all impact on what level of pull force effect there will be and the magnitude of forces involved.
The seemingly small size of magnets is often mistaken for the forces being small – they can be extremely powerful for their size which often surprises a first-time user of magnets. Some magnets are capable of over 60 psi (over 400kPa) of pressure – that is higher than most car tyre pressures!

If you have two magnets and start to bring them close to each other they will start to attract. They may rotate around to get into attraction. As they attract they move closer together. This causes the field strength between to increase resulting in more force and more acceleration and the attraction rapidly speeds up. Magnets can very quickly slam into each other with surprisingly high speed and force!
The effect is similar between a magnet and a ferrous object such as mild steel (including many tools such as screwdrivers, pliers, scissors, blades, hammers, etc - users need to consider where they place items).
Finger pinches, blood blisters and hand crushes occur when larger/powerful magnets are mishandled.

Recommendations for safe handling:-

Wear safety goggles when handling magnets.
Wear gloves when handling magnets to limit pinching of fingers.
Keep magnets at least 60cm away from sensitive electronic and storage devices.
(you may need larger distances depending on the magnetic fields)
Children should NEVER handle or play with magnets.

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Mishandling magnets can cause breaks, chips, sharp shards and sometimes sparks

Magnets are brittle. Magnets slamming together is the most common cause of broken/shattered magnets and it is possible that one or both magnets could chip, break or shatter.
Chips and sharp shards could fly off at high speed if a higher speed impact occurs, therefore eye protection is recommended to protect injury to eyes.
Chips, shards and broken magnets can have very sharp edges which can easily cut skin.
Some magnets, when they break during a collision ,may even cause sparks – magnets should not be used in explosive areas due to the explosion risk from such sparks (if you need ATEX approval, talk to us first).

Damaging forces

One of the most common injuries is finger/hand crushing. When magnets catch fingers between them, blood blisters and cuts can happen. Wearing gloves when handling smaller magnets can reduce the risk of injury (glove may get trapped instead). Larger magnets can crush fingers and break bones (gloves won't help). So always handle magnets with care and assume they are dangerous to reduce the risk of accident.

Storing magnets

Magnets are usually delivered in packaging that keeps them safe during transportation and this will often be sufficient to store them in. The packed magnets may sometimes have plastic spacers between them to aid in their separation later on but the spacers should never to be too thick as it is a trade-off between ease of separation against magnets staying securely together when packed against magnets being too loose from reduced pull (risking unnecessary accidents). If the magnets are taken out of the packaging and the magnets are fully magnetised, we recommend carefully placing the magnets onto a mild steel plate for them to clamp onto it to help hold them safely in place. But if you put magnets too near each other, they may attract to each other, possibly sliding towards each other; non-magnetic spacers help limit movement to facilitate easier separation later. If you put magnets on a non-magnetic surface, they are free to slide and be attracted to other magnets or ferrous objects nearly (such as attracting pliers or screwdrivers left carelessly on a table) causing an accident. Keep unnecessary loose ferrous objects away from the magnets. Magnets supplied unmagnetised will not attract to other unmagnetised magnets or to ferrous surfaces but will attract to nearby magnetised magnets.

Separating magnets

Magnets are easier to separate by sliding apart than attempting to pull directly away.
In all situations, great care must be taken to try to guarantee safety.
Sliding can be up to 5 times easier (depending on the surface finish – rubber coated magnets resist slides).
Smaller magnets can often be separated by hand by sliding one past the other. You may need to carefully place one magnet on the edge of a table and push the other magnet down past the edge to assist mechanically. Once separated, ensure you have moved the magnets apart enough to guarantee they won't attract to each other again. Larger magnets may need a dedicated fixture to aid safe separation. Such fixtures are custom made and use non-magnetic materials such as plastics and wood.

Field strength and performance of magnets – does shape matter?

Yes – shape definitely affects any magnet's performance. Imagine you have two N35 NdFeB magnets. One is 2mm diameter and 20mm long. The other is 20mm diameter and 2mm long. Both will work in different ways. The size, shape, environmental conditions and the total magnetic circuit all affect the magnetic performance. The grade and temperature also affects performance. Stacking magnets can give increasing performance (each design has a plateau upper height limit at which extra height offers reducing incremental increase in performance). A magnet clamping directly to steel and a magnet clamping through a gap will have different size requirements (the latter would need a bigger pole face to gain performance).

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HOW CLOSE CAN MAGNETS BE TO EACH OTHER BEFORE THEY INTERACT?

There is no simple answer to this – it is application specific and caution should be taken at all times.

Different shaped magnets give different magnetic field outputs with differing 3D field line paths.

The grade of magnet also impacts – stronger grade give more field strength.

If other magnets and/or ferrous/ferritic materials are nearby then the magnetic pathways start being affected causing changes in the pathways and attraction or repulsion – this becomes a magnetic circuit.

Ferrous materials (such as mild steel, ferritic/magnetic stainless steel, etc) attract to magnetism. Magnets will attract or repel magnetic fields from another magnet (magnets will always want to flip around to be in minimum repulsion and then into maximum attraction). This can create complex 3D magnetic field patterns. When magnets attract to items they accelerate into each other as the fields and forces rise.

A tiny magnet (e.g. D3mm x 1mmA N35 NdFeB disc) will be much different to handle compared to a large magnet (e.g. 150mm x 100mm x 25mmA C5 ferrite slab magnet) or massive several meter long overband magnet assemblies.

Some texts may suggest keeping magnets 300mm away but, from the above, this may be fine or not enough. An overkill suggestion may be to keep magnets at least 1000mm away from each other (or more, depending on the size of the magnet system and what is inside).

But perhaps a possible advisory minimum starting distance could be using double the 0.5mT distance value suggested for pacemakers and implantable defibrillators (discussed later in this document). The pull force at such a distance apart should be very low (assuming no other magnets or ferrous objects nearby to interact with the magnet being handled). But this should still require careful testing to verify what distance is actually safe to use and this suggested advisory value may be far in excess of what is actually safe for the application. When magnets interact, the fields from all the magnets will interact as well; the 0.5mT value estimations are for a magnet in free space (nothing around to interact with the magnet). There is no simple number that fits all and the users have to determine and verify a safe value for their own requirements.

You should not experiment with magnet pull forces and what may be safe if you have never handled magnets before (especially the larger / more powerful rated magnets).

If in doubt, assume the magnets are extremely powerful and put in a massive distance between them and only consider reducing the distance between magnets (or between magnets and ferrous parts) if it is safe to do so (and you need to do so, such as assembling magnets to a rotor).

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PULL FORCE TESTING

Magnets have a pull force rating, usually given a maximum possible value. The stated pull force values are sometimes estimated/predicted values. The actual pull force value will depend on the actual application. So the actual pull force measured in the application nearly always does not match the stated value (the measured value is often a much lower value) this is normal. Pull force values are given to aid in comparing magnets relative to each other to aid in selecting and designing in magnets for each application (selecting the right magnet for an application can be complex at times and we can help on this).

Small variations in magnetic performance naturally occur between magnets within each production batch and also between production batches – this is simply down to how the magnets are manufactured and is normal for any magnet factory. Magnetic performance is linked with the Br, Hc, Hci and the BH curve shape (depending on the magnet dimensions) and Direction of Magnetisation (DoM) axis – each grade has to fall within parameters specific to each magnet material grade's property values. The variation between magnets is usually very small. Explanations for such naturally occurring (acceptable production method) variations include variation in shrinkage during sintering, position within vacuum furnace, near net shape press versus slice-and-dice production, etc (the material being produced and its size, shape and magnetisation axis also impact on this to a degree).

The test results can also change with temperature because the magnet output varies with temperature. This is explained by the temperature coefficient of induction and temperature coefficient of intrinsic coercivity.

The Pull Force Test is best used on magnets with flat surfaces pulling onto a flat test bed made from ferromagnetic material (thick high quality mild steel that is much larger than the magnet being tested). If the actual application is to clamp onto a thin ferromagnetic sheet or if it clamps through an air gap, the pull forces could be considerably less.

There are two ways of performing the pull force test. One is to place the magnet directly onto the mild steel plate and to pull directly away vertically and measure the peak pull off force. This is the most commonly used method.

The other is to set the magnet sufficiently far away from the steel (so zero pull occurs) and measure the pull force with reducing gap and to continue until the gap is zero and curve fit to get a 0mm pull value.
These tests are sometimes not easily repeated and may become prone to measurement errors and poor repeatability (e.g. the pull is not perpendicular to the test bed, the magnet face is not parallel to the test bed face, etc). The extrapolation test method can provide a more effective method for calculating the force but is not always feasible for very large magnets. The direct pull off test is improved by repeating the tests to give an average, ideally using a batch of magnets.

The pull force is given in kg or N (1kg ~ 9.806N, often simplified to 1kg ~ 10N).
If the cross sectional area of the magnet is known, the force can be converted to a N/mm^2 (Pa) pressure value.

It is possible to buy Magnetic Pull Test kits – these will have their own instructions. Be cautious though because sometimes the materials used in the equipment, the size of the equipment and the shape and size of the test magnet may actually give inaccurate readings.

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PACEMAKERS, DEFIBRILATORS, MEDICAL IMPLANTS, etc

We are not medical experts so we always suggest that people with medical implants such as pacemakers, implantable defibrillators, etc should never handle magnets, magnetic assemblies or electromagnets and should always seek medical advice from their doctor before going anywhere near a magnet, magnetic assembly or electromagnet. The text below gives information for reference only and is never a substitute for getting the latest most accurate medical advice as each person's medical requirements may differ. Magnets are often described/rated as having a pull force (in Kg or N) and/or a magnetic field strength (in Gauss or Tesla). It is important to note that pull force and magnetic field strength do not correlate to each other by any simple equation - the magnetic performance output from a magnet or magnetic assembly depends on the magnetic circuitry and the application (which includes size, design, air gaps, etc). So a kg or N pull force can't simply be translated to a Gauss or Tesla magnetic field strength. For note 1 Tesla = 10000Gauss – both are accepted units of measurement of magnetic field strength from a magnet or electromagnet. The spread of magnetic field around a magnet, magnetic assembly or electromagnet can differ from application to application so the magnetic fields in each application may be hard to predict with accuracy.

The Earth's magnetic field is around 0.035 to 0.07 mT (0.35 to 0.7 Gauss). Standard magnets can produce fields up to 0.7 Tesla (7000 Gauss) at the surface (some specialist magnetic units can produce fields of 8T (80000 Gauss) or more. The magnetic field strength measured at a distance from the magnet or magnetic assembly is a function of the magnet shape, magnet size, magnet grade, temperature, magnet assembly type and the presence of any ferromagnetic material or other magnets/magnetic assemblies. So a small 1mm diameter by 1mm diameter magnet gives a vastly different field at e.g. 10cm away compared to a 1200mm x 100mm x 75mm magnetic assembly. The field strength measured from a magnet can quickly fall with increasing distance away (an inverse square law generally applies) but the size of the magnet can significantly impact on the characteristics of field pattern produced. The magnetic field strength exposure is only truly known by actually measuring the field strength with a Gaussmeter. It is this measured field strength and knowledge of the safe limits for the device(s) that determines if the environment is safe to be in.

Exposure to too high a magnetic field could possibly be fatal to people with such medical implants so we would strongly advise that people with such implants avoid magnetic fields and not approach any magnets or electromagnets until you have sought the latest medical advice from your doctor.

It is assumed that each pacemaker and implantable defibrillator design is potentially different and each would have its own mode(s) of operation and its own specification for the field strength at which their operation is affected (some units allow a magnet to change the programming mode because of an internal magnetically sensitive switch). Some devices require magnets to put the pacemakers and implantable defibrillators into a different program mode. It is also possible that, in some devices, if the magnet is left in place for long enough it can cause the defibrillator to turn off. And in other devices simply removing the magnet will put the device back into the previous program mode. So it depends on the actual device as to what effects a magnet nearby will have on its performance. As only very small magnetic fields (of possibly only up to a few mT or Gauss in some units) are required to affect pacemaker and implantable defibrillator function these units are therefore potentially extremely sensitive to magnetic fields.

From the above it is clear that any individuals with medical implants such as pacemakers, implantable defibrillators, etc should keep clear from magnets unless their doctor is performing tests on their unit and they need a magnet to perform those tests (i.e. a magnet is being used by a qualified doctor for medical reasons).

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The World Health Organisation, WHO, Fact Sheet 299 (March 2006; the reader of this should check in case a newer version exists with updated information) states:-

"Exposure to static magnetic fields has been addressed by the International Commission on Non-Ionizing Radiation Protection (see: www.icnirp.org). For occupational exposure, present limits are based on avoiding the sensations of vertigo and nausea induced by movement in a static magnetic field. The recommended limits are time-weighted average of 200 mT during the working day for occupational exposure, with a ceiling value of 2 T. A continuous exposure limit of 40 mT is given for the general public. Static magnetic fields affect implanted metallic devices such as pacemakers present inside the body, and this could have direct adverse health consequences. It is suggested that wearers of cardiac pacemakers, ferromagnetic implants and implanted electronic devices should avoid locations where the field exceeds 0.5 mT. Also, care should be taken to prevent hazards from metal objects being suddenly attracted to magnets in field exceeds 3 mT."

The April 2009 "Guidelines on Limits of Exposure to Static Magnetic Fields" by International Commission on Non-Ionizing Radiation Protection (ICNIRP) says:-

"Safety authorities need to ensure that there are restrictions to protect individuals who are wearing implanted ferromagnetic or electronic medical devices sensitive to magnetic fields. There are many individuals wearing such devices, in some cases without being aware that they have them (e.g., surgical clips). Electromagnetic interference from low-intensity static magnetic fields has been observed to affect the operation of pacemakers, particularly those with magnetic switches, and other types of medical electronic devices, including cardiac defibrillators, hormone infusion pumps (e.g., for insulin), neuromuscular stimulation devices (e.g., for the sphincter muscle of the bladder), neurostimulators, and electronically operated prosthetic devices (e.g., for the limbs and inner ear). In general, the operation of these devices is not adversely affected by static magnetic fields below 0.5 mT. In addition to potential problems arising from electromagnetic interference, many implanted medical devices contain ferromagnetic materials that make them susceptible to forces and torques in static magnetic fields. These mechanical effects can lead to the movement and potential dislodging of implanted ferromagnetic devices, especially those of large size such as hip prostheses. Other ferromagnetic devices that might be affected include aneurysm clips, metal surgical clips and stents, heart valve prostheses and annuloplasty rings, contraception implants, cases of implanted electronic devices, and metallic dental implants, although most modern implants are not ferromagnetic. The safety of exposing these devices to the fields used in MRI has been extensively studied (New et al. 1983; Kanal et al. 1990; Shellock and Crues 2004). From studies performed to date, there is no evidence that static magnetic fields at or below the level of 0.5 mT would exert sufficient forces or torques on these devices to create a health hazard. Accordingly, warning signs or lines are drawn around locations with magnetic flux densities >0.5 mT to mark public exclusion zones, for instance around MRI systems."

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Examples of distance away from magnets at which the 0.5mT field is estimated to be measured (magnet in free space – no other magnets or ferrous parts to affect/interact with the magnet):-

6inch x 4inch x 1inchA Ferrite C5 magnet: -	***~375mm away (14.8 inches) for 0.5mT***
50mm x 50mm x 25mmA N35 NdFeB magnet: -	***~275mm away (10.8 inches) for 0.5mT***
50mm x 50mm x 12.5mmA N35 NdFeB magnet: -	***~221mm away (8.7 inches) for 0.5mT***
D25mm x 10mmA N35 NdFeB magnet: -	***~120mm away (4.8 inches) for 0.5mT***
D3mm x 1mmA N35 NdFeB magnet: -	***~14mm away (0.55 inches) for 0.5mT***
250mm x 250mm x 50mmA N52 NdFeB magnet: -	***~751mm away (29.6 inches) for 0.5mT***
25mm x 10mm x 5mmA N35 NdFeB magnet: -	***~75mm away (3 inches) for 0.5mT***
40mm x 20mm x 10mmA N52 NdFeB magnet: -	***~150mm away (6 inches) for 0.5mT***
1200mm x 100mm x 75mmA Ferrite assembly: -	***~over 1000mm away (40 inches) for 0.5mT***

Field strengths can be measured with a Gaussmeter (measured in Gauss or Tesla) – predicting the field using online calculators, spreadsheets, etc may be prone to miscalculation and cannot take into account real world application variables.

Magnetic fields exist all around us – examples include loudspeakers, headphones, electric motors (e.g. washing machines, vacuum cleaners), electric generators, MRI devices, magnetic therapy products, many position sensors, magnetic cupboard and door catches, fridge magnets, shower doors, fridge doors, magnetic knife racks, magnetic boiler filters, etc.

The Earth's magnetic field is also present everywhere but it is around 0.035 to 0.07 mT (0.35 to 0.7 Gauss). Standard magnets can produce fields up to 0.7Tesla (7000 Gauss) at the surface (some specialist magnetic units can produce fields of 10T or more (100000 Gauss).

So how far from a magnet should you be to be safe? Unfortunately there is no simple answer – you actually have to measure the environment with a Gaussmeter to know for sure (to be less than 0.5mT based on WHO Fact Sheet 299). So although a guide of at least 30cm away is often stated by many, the actual distance required to remain safe may actually be significantly larger than this (e.g. well over 1000mm away). The field from a 1mm diameter disc magnet is different to that from an industrial overband separator for example. A magnetic field strength value may be specified as a safe value by your doctor – it can only be measured near a magnet or magnetic assembly using a calibrated Gaussmeter near the unit.

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TRANSPORTING MAGNETS BY AIR – IATA Regulations

There are strict regulations which apply to the transportation of magnets by air. The International Air Transport Association (IATA) Dangerous Goods Regulation Packing Instruction 953 defines when a magnet is deemed as dangerous goods and if it is to be restricted.

The reason why the IATA Dangerous Goods Regulation exists is because the magnetic fields from the magnets could, if not shielded correctly, interfere with the airplane's compass, navigation and electrical systems which could have catastrophic consequences. The test specification is strict and failure to comply results in the goods not being allowed on the airplane and possibly even in confiscation of the goods by airport security – it is taken extremely seriously. Please note that Airlines have the right to refuse to accept magnets on board their flights (they can actually refuse any package). Land couriers may also refuse to accept magnetic packages without relevant documentation (they may accept the package if you can provide documentation that proves the package passes the IATA tests).

Magnetic field strength is measured with a Gaussmeter (sometimes it is also called an Oersted meter). If the total measured magnetic field exceeds 0.00525 Gauss (0.525 μTesla or 525nT) at 15 feet from the package in any direction, the package cannot be accepted for air shipment. If the total measured magnetic field passes the above specification but exceeds 0.002 Gauss (0.2 μTesla or 200nT) at 7 feet from the package in any direction, the package can be accepted for air shipment but it must be suitably packed according to IATA Dangerous Goods Regulation Packing Instruction 953 (this has replaced IATA Dangerous Goods Regulation Packing Instruction 902). The IATA Dangerous Goods Declaration Form must be completed and the package labelled appropriately including the "Handling Label for Class 9 - Magnetized Material" label.

If the total measured magnetic field is less than 0.002 Gauss (0.2 μTesla or 200nT) at 7 feet from the package in any direction, the package can be accepted for air shipment and the magnet material in the package is classified as "not restricted". An IATA accepted alternative test is to have less than 0.5 degrees deflection of a compass at 7 feet away.

Magnetic field strength roughly follows an inverse square law. So if you were to measure the magnetic field strength at double the distance away, you should measure a quarter (25%) of the field strength. Conversely if you half the distance away you will get around quadruple the field strength (400%). By being stricter and testing the package at less than 7 feet away for less than 0.5 degrees deflection (less than 0.002 Gauss) from all positions, this stricter test should ensure the package is classified as "not restricted" by IATA Dangerous Goods Regulation.

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To make strong magnets pass the IATA tests, the magnets are usually packaged with ferromagnetic steel-lined containers (1mm thick or more typically). The steel (e.g. ferromagnetic mild steel) blocks the magnetic fields from passing beyond the package (sometimes a second steel layer is required, separated by a spacer because extremely strong fields magnetically saturates the first layer and then passes through the first layer). Thicker steel can provide better magnetic field shielding but sometimes a double layer is superior at blocking fields. However adding mild steel lining plates to the inside of the packaging results in the weight of the package increasing making it more expensive to air freight – sea/road freight may then be a cheaper/easier. Sea/road freight requires less safety packaging and is cheaper but the delivery lead time becomes much longer.

PACKING INSTRUCTION 953

This instruction applies to UN 2807, **Magnetized material** on passenger aircraft and Cargo Aircraft Only.

Magnetized material will be accepted only when:

(a) devices such as magnetrons and light meters have been packed so that the polarities of the individual units oppose one another;

(b) permanent magnets, where possible, have keeper bars installed;

(c) the magnetic field strength at a distance of 4.6 m (15 ft) from any point on the surface of the assembled consignment:

  (1) does not exceed 0.418 A/m (0.00525 gauss), or

  (2) produces a magnetic compass deflection of 2 degrees or less.

Note: For loading instructions see 9.3.11.

Determination of shielding requirements

The magnetic field strength of magnetized materials must be measured using measuring devices having a sensitivity sufficient to measure magnetic fields greater than 0.0398 A/m (0.0005 gauss) within a tolerance of plus or minus 5%, or with a magnetic compass sensitive enough to read a two-degree variation, preferably in 1 degree increments or finer. Methods of determining if a magnetized article meets the definition of a magnetized material include:

Method 1— When an oersted meter is used, it is placed on one of two points positioned 4.6 m (15 ft) apart and located in an area that is free from magnetic interference other than the earth's magnetic field. The oersted meter is then aligned with the second point and “balanced” to a zero reading. The magnetic article is then placed on the other point and the magnetic field strength is measured by reading the meter while rotating the package 360 degrees in its horizontal plane. If the maximum field strength observed is 0.418 A/m (0.00525 gauss) or less, the article is acceptable for air transport. When the maximum field strength exceeds 0.418 A/m (0.00525 gauss) shielding should be applied until a reading of 0.418 A/m (0.00525 gauss) or less has been attained.

Method 2— When a magnetic compass is used as a sensing device, it should be placed on one of two points positioned 4.6 m (15 ft) apart which are aligned in an East/West direction and in an area that is free from any magnetic interference other than the earth's magnetic field. The packaged item to be tested is placed on the other point and rotated 360 degrees in its horizontal plane for indication of compass deflection. When the maximum compass deflection observed is two degrees or less, the article is acceptable for air transport. When the maximum compass deflection of an item exceeds 2 degrees, shielding must be applied until the maximum deflection is not more than 2 degrees.

If the maximum field strength observed at a distance of 2.1 m (7 ft) is less than 0.159 A/m (0.002 gauss) or there is no significant compass deflection (less than 0.5 degree), the article is not restricted as a magnetized material.

If we send a magnet within the UK or abroad by Road, we will not necessarily have packed the magnets for IATA. If we ship abroad, we will pack the magnets as necessary to get to the end user. If the End User sends magnets onwards, IATA compliance is their responsibility not ours.

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BANK CARDS AND MAGNETIC STRIP CARDS – USING THEM NEAR MAGNETS

It is recommended that magnets be kept away from magnetic strips on cards such as bank cards – the fields could damage the magnetic pattern on them. It may be possible to use magnets near to credit cards if you are aware of the field strength output from the magnets and keep them within acceptable limits but if you get it wrong the strip is damaged instantly, so if in doubt, keep them far apart.

We cannot accept any responsibility or liability whatsoever if a magnet does affect a magnetic strip's performance – it is the user's responsibility at all times. The below is given as a quick rough guide for reference only (exceptions and updates may exist).

ISO IEC 7811 is one of the main standards relating to magnetic characteristics on cards that contain magnetic strips. The magnetic strip on the card stores data in the form of a magnetic pattern (a unique pattern of Norths and Souths). The strip is a very thin layer of permanent magnet material. It is this magnetic pattern that can be affected by external magnetic fields from permanent magnets, electromagnets, and even other bank cards.

There are two type of magnetic strip on cards – low coercivity (LoCo) and high coercivity (HiCo). The actual shape of the magnet, the magnet type, the grade of magnet and the distance from the magnet to the magnetic strip will determine whether a LoCo or HiCo magnetic strip will be affected by an external magnetic field.

Low coercivity (LoCo) cards have a Hci (magnitude of external demagnetizing magnetic field H that must be applied to a magnet to completely demagnetise it) of 300 Oersteds. Examples of these are cards used in car parks, loyalty cards and old design banking cards (Credit Cards, Debit Cards, etc). The strips are brown in colour due to the gamma ferric oxide used. For LoCo strip – if the magnetic field applied to the strip is near or above 300 Gauss (0.03T), the strip could be altered/demagnetised.

High coercivity (HiCo) cards have a Hci of between 2500 and 2900 Oersteds but there is a trend of moving towards 2750 Oersteds. Examples of these some modern design Bank Cards (Credit Cards, Debit Cards, etc). The strips are a dark grey colour due to the particles of barium ferrite (like that of the Ceramic / Ferrite magnets). For HiCo strip – if the magnetic field applied to the strip field is near or above 2500 Gauss (0.25T), the strip could be altered/demagnetised. HiCo strips are much harder to demagnetise but research by VISA found that typically about 3% of magnetic strip based transactions failed due to magnetic failure of the strips - ladies' hand bag magnetic clasps being one of the primary causes of the magnetic failure. Once the strip has been affected (the change, when it happens, is instantaneous and cannot be seen by the eye) it cannot be repaired/undone.

Magnetic fields near magnetic strip

Any magnet could provide enough magnetic field to affect a LoCo strip (this includes fridge magnet material). With the HiCo strips, there could be occasions when Alnico and Ferrite could be powerful enough to affect it but most NdFeB and SmCo magnets could very easily completely demagnetise LoCo strip and alter the entire magnetic pattern of the HiCo strip as well. Some magnets can produce fields well in excess of 10000Gauss (1.0T) – the magnetic circuit, design and application will affect the magnitude of field measured.

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LONGEVITY OF MAGNETS – how long will a permanent magnet stay magnetic?
How long any magnet retains its magnetism for will depend upon the application and the environment that magnet is placed in.

If a permanent magnet is well looked after, not damaged, kept at room temperature, kept in a dry environment away from moisture, corrosion risks, radiation and external magnetic fields, it will in theory remain magnetic indefinitely (i.e. it could outlast the product lifecycle). As a rough guide based on well looked after magnets over 10 years the drop in performance for high permeance coefficient magnets should be very low e.g. nearing 0% for NdFeB, nearing 0% for SmCo, under 2% for ferrite and under 3% for alnico. In practice the conditions are not ideal so the long term performance could well be worse (or far worse) than stated (so please do not use the guideline values as to be expected values – you could be disappointed).

However, taking a magnet such as an NdFeB (Neodymium magnet) to an excessive temperature will start to demagnetise that magnet (irreversible but recoverable loss) weakening it and extreme heat will completely demagnetise it. Exposure to higher moisture environments will expose the NdFeB Neodymium magnet to a corrosion risk (especially salt spray and marine environments). Heat can also play a part in the corrosion process. Corrosion causes a permanent loss in magnetic performance and can eventually cause a total magnetic failure. It is for this reason that, in safety critical applications where moisture and corrosion is possible, SmCo Samarium Cobalt magnets or Ferrite magnets are preferred as these will not corrode when in damp or wet conditions (and why SmCo Samarium magnets are often a first choice in military and aerospace applications). How long it takes for corrosion to be seen really depends on the application and the environment. In dry conditions it may never be seen. In damp conditions it could take years, months, perhaps in damper conditions weeks. In wet conditions, corrosion could be noted in weeks or even days. If the coating is damaged, corrosion can occur faster. The coating type will help in minimising corrosion risk e.g. zinc plated NdFeB Neodymium magnets with a rubber overcoat layer can perform better than a standard Ni-Cu-Ni layer and Everlube coatings are reported to be good for corrosion resistance. The latest grades of corrosion resisting NdFeB Neodymium magnets have also improved the alloy's resistance to corrosion (although still not preventing it, the time taken before corrosion is seen is extended – these grades do carry a price premium).

SmCo Samarium magnets do not corrode as badly as NdFeB Neodymium magnets. Alnico magnets do not corrode badly either. Both are much better with water than NdFeB (both should be given some protection against corrosion but their rates of corrosion are not as bad as NdFeB). Ferrite will not corrode with water.

If the NdFeB is taken to too high a temperature it will start to magnetically weaken (by definition, this is an irreversible but recoverable loss – only recoverable by remagnetising). Too high a temperature and the magnet can be totally demagnetised and extreme heat can change the alloy composition resulting in an irreversible irrecoverable loss (in that remagnetising will not regain the original performance). The same applies for SmCo, Ferrite and Alnico. Alnico copes with the highest temperatures followed by SmCo, Ferrite then NdFeB. Ferrite will demagnetise when it gets too cold (because ferrite, unlike the others, gets a significant reduction in Hci as it cools down – SmCo and NdFeB increase Hci as they cool down).

All magnets are brittle – striking the magnet will potentially damage it, perhaps with sections breaking away. For note, it is possible to get sparks when SmCo and NdFeB chips off, so magnet use in explosive environments is not recommended unless it is within a protected housing assembly (e.g. plastic encapsulated). A harder strike on any magnet will break the magnet into pieces – the shards can be very

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sharp and the resulting broken magnet will usually collect to itself with shards rotating around to leave a weakened unusable 'scrap' magnet.

In conclusion it is feasible to have a permanent magnet that will stay magnetic forever but your application may not make this possible. Your application, its environment and the magnet choice and magnet design will all affect how well magnets last and which magnets should be used (or avoided). If a guaranteed long lifespan is required, SmCo or Ferrite may possibly be better suited magnetic materials. If in any doubt please contact us for advice.

CHILDREN AND MAGNETS

Keep all magnets out of the reach of children. Children should not be allowed to play with magnets. Magnets can cause finger and hand traps but ingesting magnets is also big risk. If more than one magnet is swallowed, they can attract each other through the walls of the intestines, get stuck and pinch the digestive tract resulting in potentially life-threatening injuries that can only be treated with surgery.

STILL UNSURE? NEED MORE HELP?

Do not use magnets if you have not performed a risk assessment.

The user / handler of magnets is responsible for their own safety at all times.

Please contact us if you need any help or assistance or are not sure.

PLEASE NOTE

Although we have tried to make this document as accurate as possible we do not guarantee accuracy of the information or that it is kept updated at all times - we reserve the right to change/amend this document without notice or prior warning and it is not our responsibility to inform anyone of any changes we make to this document.

This document is merely a guide for your review.

Laws and Regulations, etc may change and it is the user's responsibility to be aware of any such changes which we will update this document with when necessary.

We accept no responsibility or liability whatsoever for any accidents or incidents involving magnets or reliance on information in this document.