X-POT MAGNETIC FIELD HEALTH & SAFETY

www.bssboss.com
BOSStechnicalteam@bssgroup.com
03330 341920
BSS, Ashcroft Way, Cross Point Business Park, Coventry CV2 2TU
BSS, Duncrue Industrial Estate, 36-38 Duncrue Rd, Belfast BT3 9BP

Health & Safety Information for X-POT Magnetic Field -

World Health Organisation Statement

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 1mT**. Also, care should be taken to prevent hazards from metal objects being suddenly attracted to strong magnetic field sources.

https://www.who.int/peh-emf/publications/facts/fs299/en/

Magnetic Field Damage -

Gauss	Tesla	Description
5	0.5mT	Highest allowed field for implanted cardiac pacemakers.
10	1mT	Watches, credit cards, magnetic tape, computer disks may be damaged.
30	3mT	Small ferrous objects present a kinetic energy hazard.
20,000	2T	Whole-body ceiling limit (no exposure allowed above this limit).
80,000	8T	Whole-body (special worker training & controlled workplace environment).
200,000	20T	Extremity ceiling limit (no exposure allowed above this limit).

Effects of Static Magnetic Fields

https://ehs.lbl.gov/resource/documents/radiation-protection/non-ionizing-radiation/electromagnetic-radiation-and-fields/

EU Directive 2013/35/EU, HSE Regulations (Electromagnetic fields at work), STFC Safety Code No 6 & 39 -

https://www.hse.gov.uk/pubns/books/hsg281.htm

1. **4.2.5** Locate warning signs at all entrances to areas containing magnetic fields with strengths greater than **0.5mT** (5 Gauss).

2. **4.2.6** Ensure that warning signs and other measures, e.g. barriers or floor marks, are set up around areas where hazards arising from static magnetic fields could exist. The barriers, or floor marks, should define a zone **outside which the magnetic field is less than 3mT (<30 Gauss)** in order

to delineate the boundary where magnetisable materials such as tools may be accelerated and present projectile hazards, see Appendix 1a.

3. **4.4.2** Ensure, if any person has an implanted medical device such as a heart pacemaker, that he or she informs his or her manager or other person responsible for his or her safety before entering an area where static magnetic fields greater than 0.5mT (5 gauss) are present in the working environment. Anyone with an implanted medical device may wish to contact Occupational Health or the SHE Group for advice on the likely sensitivity of the implanted medical device to magnetic fields.
https://www.she.stfc.ac.uk/Pages/SC39-Static-magnetic-fields.aspx

   Directive **2013/35/EU** of the EU on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields).

Appendix 1. Summary of hazards associated with strong static magnetic fields.
https://www.she.stfc.ac.uk/Pages/SC39-Appendix-1.aspx

a) Physical/Collision Hazards

Danger is frequently encountered where loose magnetic or magnetisable objects are in the vicinity of strong magnetic fields or where magnetic field gradients are high. The field may be strong enough to attract such objects and to cause them to fly along the field lines towards the magnet – the 'missile effect' or simply a crushing effect. Therefore metallic objects such as rings, glasses, watches, coins, steel toe caps and in particular those with sharp edges, keys, scissors, tools, gas cylinders, trolleys, vacuum cleaners etc. may become dangerous projectiles and their use should be controlled in any areas where the magnetic field exceeds 3mT (30 Gauss). Consideration should be given to establishing systematic search protocols before such magnetic fields are started up to ensure that relevant areas are free from loose magnetic objects.

Permanent Magnets

Permanent magnets, particularly rare earth magnets, can pose extra hazards since, by their nature, they are always generating a strong static magnetic field and gradient. Extra precautions need to be taken when handling them as the risk of pinching skin and crushing fingers is high. **The magnets should only be handled one at a time**, unless special fixtures are being used to restrain them, and non-magnetic tools should always be used in the vicinity of permanent magnet blocks or magnet assemblies that are powered by permanent magnets.

Movement of conducting materials in static magnetic fields

The movement of electrically conducting materials in strong static magnetic fields can result in the generation of eddy currents in the conductor which should be considered if assessing hazards.

Effect on medical implants

Persons wearing artificial metallic implants may feel painful sensations. Wearers of heart pacemakers, for instance, should be aware of the possibility of interference from magnetic fields.

"ICNIRP recognises that practical policies need to be implemented to prevent inadvertent harmful exposure of people with implanted electronic medical devices and implants containing ferromagnetic materials, and injuries due to flying ferromagnetic objects, and these considerations can lead to much lower restriction levels, such as 0.5mT [5 Gauss] (IEC, 2002).", ICNIRP Fact Sheet, 2009. icnirp.org/cms/upload/publications/ICNIRPFactSheetStatic.pdf

The following signs should be employed to warn those with medical implants of the hazards posed by strong static magnetic fields.

Up to date data from website:

Passive medical implants that contain ferromagnetic materials may be subject to forces and torques in the presence of strong static magnetic fields, which can result in movement of the implant that could result in injury to the wearer. The following types of implant may be susceptible, although it should be noted that this list is not necessarily exhaustive and not all implants of a given type will be manufactured from the same materials:

- Artificial joints
- Aneurysm clips
- Metal surgical clips
- Stents
- Heart valve prostheses and annuloplasty rings
- Contraceptive implants
- Cases of active implants
- Dental implants

Active medical devices may be subject to electromagnetic interference from strong external static magnetic fields. This is a particular issue where the device contains a magnetic switch, which is often included in the design to permit the device to be switched from outside the body. The following non-exhaustive list gives examples of devices that may be susceptible:

- Cardiac pacemakers
- Implanted cardiac defibrillators
- Neuromuscular stimulation devices
- Neurostimulators
- Cochlea implants
- Electronically operated prosthetic devices
- Hormone infusion pumps

In general, medical implants and body-worn devices are not normally affected by fields less than 0.5 mT (5 Gauss).

b) Biological Hazards

Although present knowledge of the possible biological effects of strong static magnetic fields is still somewhat uncertain, some evidence has been obtained which indicates that simple biological systems may be affected by exposure to strong static magnetic fields. There is no specific information regarding possible long term health effects from exposure and none have been observed so far.

Investigations have been carried out to ascertain the effect of magnetic fields on humans, very few have shown any effect; in one or two cases associated with high magnetic fields it has been claimed that slight headaches, disorientation and slight feelings of nausea have ensued especially when there is movement in a static magnetic field. The only effect on which there appears to be some agreement is that of a metallic taste sensation, possibly due to loose metal fillings in teeth, when exposed to high magnetic fields.

"For static magnetic fields in excess of 2-4 T, physical movement in static field gradient will induce sensations of vertigo and nausea that, although transient, may aversely affect people. Together with possible effects on eye-hand co-ordination, the optimal performance of workers executing delicate procedures could be reduced, with a concomitant [consequential] impact on safety. Other acute effects are less clearly established; cardiovascular responses, such as changes in blood pressure and heart rate, have occasionally been observed in volunteer and animal studies, but lie within the normal range below 8 T."

Health Protection Agency (HPA) website 2010 It is therefore recommended, wherever possible, that reasonable and simple measures to limit such exposure should be adopted, particularly exposure of the head or whole body. Where exposure to high magnetic fields in working situations cannot be avoided then the exposure limit values detailed in reference 4.2 should be considered.

Up to date data:

Movement through a strong magnetic field generates electric fields in the body that may affect excitable tissues. The organs of balance are particularly sensitive, leading to feelings of dizziness (vertigo), when walking through, or quickly moving the head in the field. The tongue may also be affected with a metallic taste in the mouth often reported. Other symptoms can include nausea. These are all considered to be sensory effects and normally only occur at fields in excess of 2 T. Where it is necessary for exposures to exceed 2 T, effects can be limited by avoiding rapid movements, although there is limited recent evidence to suggest that these effects may occur in the absence of movement.

As noted above, when a conductor moves in a static magnetic field, an electric field will be induced in the conductor. As blood is conductive, its flow in a strong field will result in the induction of electric fields even when the person is not moving. The magnitude of the induced flow potential depends on the strength of the magnetic field, the velocity of blood flow and the diameter of the blood vessel; the strongest electric fields will be induced by flow through the aorta and have the potential to disrupt the sinoatrial node. These electrodynamic effects should not occur to any significant extent for fields less than 8 T.

When a static magnetic field is applied perpendicular to the direction of blood flow, magnetohydrodynamic forces will act to reduce the flow rate. The magnitude of this effect is approximately proportional to the square of the magnetic field strength; aortic flow rates would be reduced by around 5% at 10 T. Similar effects are possible in other major blood vessels. Collectively electrodynamic and magnetohydrodynamic effects are considered to be adverse health effects, but should not be significant provided exposures do not exceed 8 T.

X-POT Model & Magnetic Field Exposure When Contained Within the X-POT -

Table 1

X-POT Model	Range from X-POT	Micro Tesla (uT)	Milli Tesla (mT)	Max mT (HSE)
X-POT Compact	5 meters	0.003	0.000003	0.5
X-POT Compact	5 meters	0.006	0.000006	0.5
X-POT Compact	3 meters	0.006	0.000006	0.5
X-POT Compact	2 meters	0.006	0.000006	0.5
X-POT Compact	1 meters	0.012	0.000012	0.5
X-POT Compact	0 - Direct Proximity	3.11	0.00311	0.5

Table 2

X-POT Model	Range from X-POT	Micro Tesla (uT)	Milli Tesla (mT)	Max mT (HSE)
X-POT 6	5 meters	0.005	0.000005	0.5
X-POT 6	5 meters	0.009	0.000009	0.5
X-POT 6	3 meters	0.009	0.000009	0.5
X-POT 6	2 meters	0.009	0.000009	0.5
X-POT 6	1 meters	0.018	0.000018	0.5
X-POT 6	0 - Direct Proximity	4.67	0.00467	0.5

Table 3

X-POT Model	Range from X-POT	Micro Tesla (uT)	Milli Tesla (mT)	Max mT (HSE)
X-POT XP	5 meters	0.01	0.00001	0.5
X-POT XP	5 meters	0.02	0.00002	0.5
X-POT XP	3 meters	0.02	0.00002	0.5
X-POT XP	2 meters	0.02	0.00002	0.5
X-POT XP	1 meters	0.04	0.00004	0.5
X-POT XP	0 - Direct Proximity	10.11	0.01041	0.5

Table 4

X-POT Model	Range from X-POT	Micro Tesla (uT)	Milli Tesla (mT)	Max mT (HSE)
X-POT HFHP	5 meters	0.04	0.00004	0.5
X-POT HFHP	5 meters	0.08	0.00008	0.5
X-POT HFHP	3 meters	0.08	0.00008	0.5
X-POT HFHP	2 meters	0.08	0.00008	0.5
X-POT HFHP	1 meters	0.16	0.00016	0.5
X-POT HFHP	0 - Direct Proximity	40.44	0.04044	0.5

X-POT Summary Overview for Building Managers, Health & Safety Officers and Operatives -

UK & EU standards advise any magnetic field greater than 0.5 mT will require workplaces locate warning signs at all entrances to areas containing magnetic fields with fields **greater than 0.5mT (5 Gauss)**. All X-POTs in situ of workplaces **fall well below 0.5mT (5 Gauss)** and therefore **warning signs at entrances are not required**, only the plant/equipment (X-POT) is required to be labelled. All X-POTs are delivered with warning signs within the crate for the Installer. The Insulation Jacket also provides warning to operatives not to service the X-POT if they have any medical implants/devices fitted.

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https://apps.who.int/iris/bitstream/handle/10665/39599/9241542691-eng.pdf?sequence=1&isAllowed=y

Fig 1.

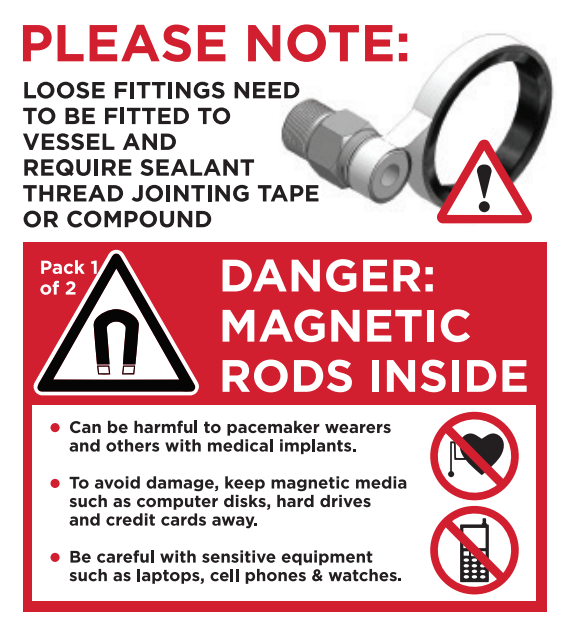

Fig 2.

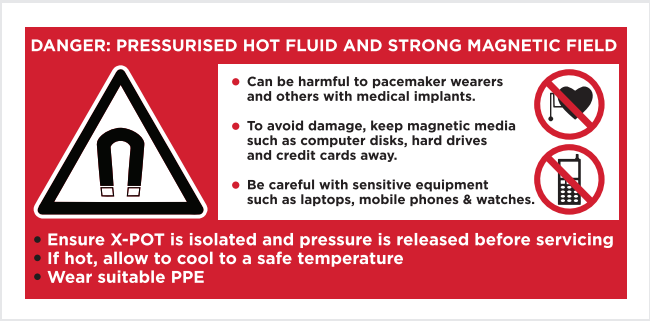

Fig 1 - Label supplied in X-POT Crate

Fig 2. - Label contrained on top lid (Insulation jacket)

Risk of Crushing with Magnets

As per Directive **2013/35/EU** the X-POT magnets have been designed to sit in a structure which separates the magnets (via magnet grate)- This allows the operative to **safely remove each magnet <u>one at a time</u>**. This information is also detailed within the laminated O&M manual which is issued with each X-POT (actions 15-17).

Transport Regulations for Equipment Containing Strong Magnets -

Transporting products containing magnets may cause detrimental effects to aircraft instrumentation, and when by sea, rail, or road this could also apply to other goods being transported in proximity. Therefore, the most stringent guidelines are applied by the FFA & IATA guidelines and will be observed in this case.

Air -

There are two important measurements of a package containing magnets.

- Rule #1: For any package shipped by air, whether It is labelled magnetic or not, the field strength must be 5.25 milligauss or less at a distant of 15 feet (4.57m) from the surface of the packaging (49 CFR, Part 173.21 Forbidden materials and packages). If the package measures above this value, don't ship it by air.

- Rule #2: If the field strength is 5.25 milligauss (0.00525 gauss) or more at 7 feet (2.12m) from the package, the IATA (International Air Transport Association) says the package needs to be labelled as Magnetic. This is especially applicable for international shipments.

The X-POTs (as seen in tables 1-4)- All BOSS X-POTs do not require labelling for transport.

The magnetic field when the X-POT is packaged within its crate will be less than those detailed in tables 1-4.

Simple calculator for converting magnetism from Gauss to Tesla:

https://www.convert-measurement-units.com/conversion-calculator.php?type=magnetic-field

As with all manufacturers technical and O&M Information- The Operative should be a competent person to operate HVAC equipment and always read/follow manufacturer's instructions.