
# E-Magnets UK Ltd

## PULL FORCE CALCULATION

This document provides the procedure for testing the maximum possible pull force from a magnet. It may be possible to use the theory contained in this document to adapt the test for different magnets and assemblies. If in any doubt, please get in touch.

### The Equipment :

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

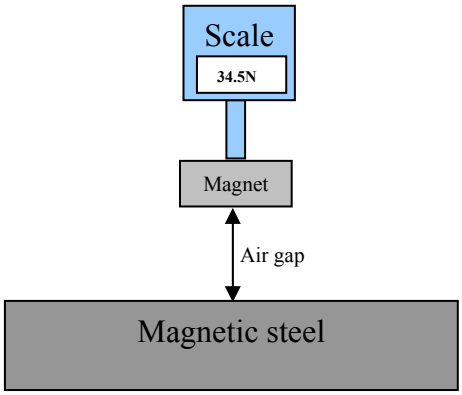
The Magnetic Pull Test is primarily used on magnets with flat surfaces pulling onto a flat surface ferromagnetic material (high quality mild steel) test bed. The forces are measured on a calibrated scale. This scale is ideally electronic. The test must be repeatable.

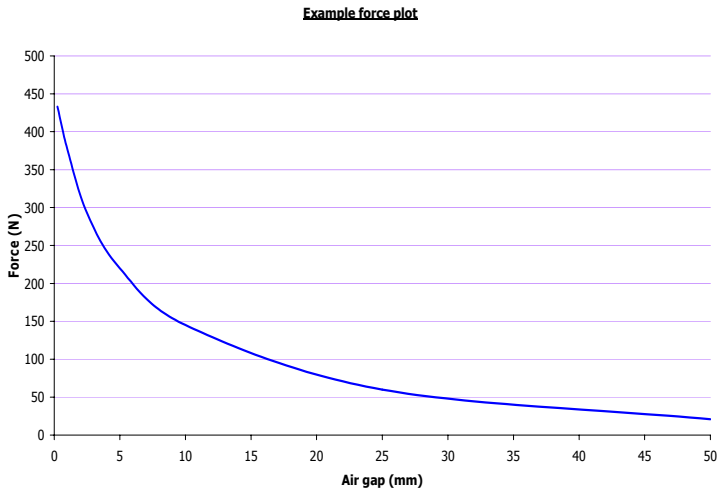
### The Test (Extrapolation Test):

Set the scale such that the test magnet would be as far away from the ferromagnetic test bed as possible so that the magnet exerts no force on the test bed. Add the test magnet to the scale. Standard tests require the direction of magnetisation to be in the vertical plane. Zero the scale (this removes the magnet weight due to gravity component). Note both the force value on the scale and the distance between the magnet and the test bed (this distance is the air gap). In a situation where the magnet still pulls because the air gap is too small, zero the scale before adding the magnet and then take the measurements but compensate for the magnet weight (force of gravity) afterwards.

Slowly reduce the air gap distance (the magnet gets closer to the test bed). Measure the new air gap distance and the new force reading. Continue the process until the air gap is 0 (zero) mm.

Plot the results. Extrapolate the force that would be achieved at 0 mm. This is the maximum pull force. It is usually given in Newtons, N.



**Additional Information:**

The tests are based on the magnet clamping onto a thick ferromagnetic slab. If the actual application is to clamp onto a thinner ferromagnetic sheet, the pull forces will be considerably less. You could adapt the test to replicate your application to get more applicable results (see below for ideas).

The test assumes that the ferromagnetic test bed is much larger in size than the magnet test piece. The test also assumes that all other material nearby is either non-magnetic or far away enough so as to not affect the results. Do not assume the test equipment bought is non-magnetic – test it.

If the cross sectional area of the magnet is known, the force can be converted to a $N/mm^2$ value.

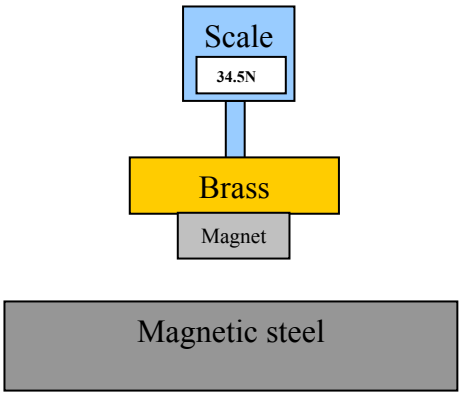
If you put the magnet onto the test bed and remove it with a pull force in excess of the value calculated then the magnet will be removed from the test bed and this test can be used. However, such tests are not easily repeated and are often prone to errors and poor repeatability (e.g. the pull is not perpendicular to the test bed, the magnet face is not parallel to the test bed face, etc). The extrapolation test method provides a more effective method for calculating the force. The direct pull off test is improved by repeating the tests to give an average, ideally using a batch of magnets.

When testing magnets, please note that variations within a batch and from batch to batch should be expected – this is simply down to how the magnets are manufactured as magnetic properties vary slightly from magnet to magnet (the performance is linked with the Br and the BH curve shape, depending on the magnet dimensions). The variation is usually very small.

The test results will vary with temperature because the magnet output varies with temperature. This is explained by the temperature coefficient of induction and temperature coefficient of intrinsic coercivity. Ideally perform all tests at the same temperature.

**Makeshift test – an example:**

Buy a thick high quality ferromagnetic slab, a large non-magnetic slab (e.g. brass), a measuring scale (e.g. a spring balance), a means to connect the non-magnetic slab to the scale (e.g. hook) and a non-magnetic measuring rule (e.g. plastic ruler). Glue the magnet to the underside of the non-magnetic slab. Put the non-magnetic slab on the spring balance. Perform extrapolation pull test but compensate for the weight of the brass, connector and magnet.




**How to contact us:**

We believe in listening to, understanding and working with our customers. We have a dedicated, expert sales team who are available Monday to Friday from 8.30am to 5.30 pm (GMT). If you have any queries or would like us to visit you, please get in touch:

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