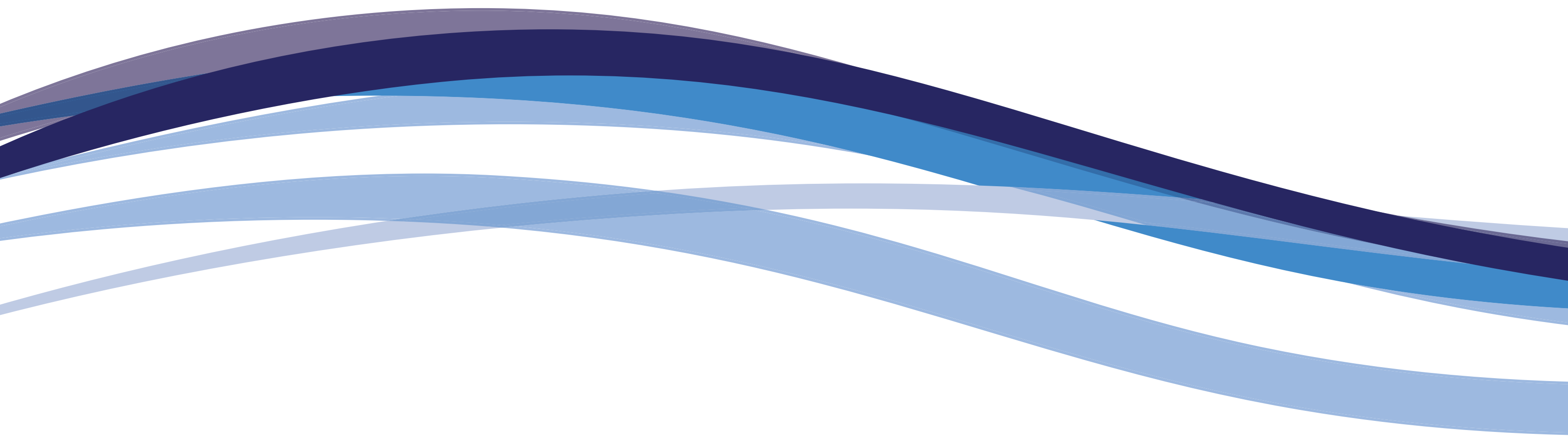
MμShield®

MAGNETIC SHIELD SAMPLE & DESIGN KIT

AS9100 & ISO 9001:2015 CERTIFIED | ITAR REGISTERED



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WELCOME

GREETINGS FROM NEW HAMPSHIRE!

Thank you for purchasing MuShield's Magnetic Shielding Design Kit!

In this kit you will find resources to help design and build your own magnetic shield. This kit is the first step to solving your magnetic interference problem. Read the information given in this pamphlet and start working with the materials to gauge what type of magnetic shield best suits your specific need. After reviewing the technical data, start working with the various types of materials found in this kit.

MATERIALS FOUND IN THIS KIT

Note that all materials are in the mill annealed condition. Subsequent heat treating is needed to restore the material to its maximum magnetic permeability.

MUSHIELD HIGH PERMEABILITY FOIL (1 of each)

Material per ASTM A753 Alloy Type 4 and MIL-N-14411 Composition 1

.004" x 15" x 12"
.006" x 15" x 12"
.010" x 15" x 12"

MUSHIELD HIGH PERMEABILITY SHEET (1 of each)

Material per ASTM A753 Alloy Type 4 and MIL-N-14411 Composition 1

.020" x 6" x 8"
.040" x 6" x 8"
.060" x 6" x 8"

MUSHIELD MEDIUM PERMEABILITY FOIL (1 of each)

Material per ASTM A753 Alloy Type 2 and MIL-N-14411 Composition 3

.020" x 6" x 8"
.040" x 6" x 8"

MUSHIELD LOW PERMEABILITY (HIGH SATURATION) SILICON IRON SHEET (1 of each)

.007" x 14.5" x 12"

LAMINATED ADHESIVE - DOUBLE SIDED

2 Square ft.

HOW MAGNETIC SHIELDING WORKS

BY: DAVID GRILLI

Sr. Magnetic Shielding Applications Engineer & President

When it comes to discussing magnetic shielding, a number of terms are tossed around that make sense to electrical engineers, which can be confusing to the rest of us. **High Permeability, Medium Permeability, High Saturation, High Flux Density Magnetic Field,** and **Attenuation** are words that I had to come to terms with as I learned the science behind magnetic shielding. Even with my vast technical background in electronics, I was an amateur when I first started working with magnetic shielding. Now, with 40 years of industry experience under my belt, I have developed some tips and tricks to better understand and teach the science behind magnetic shielding.

As a nature lover, I look for analogies in the world around us to enable a better understanding of various electrical phenomena. For example, when I learned how magnetic fields work, I imagined the expanding rings on the surface of a pond caused by a single drop of water.

Magnetic flux actually looks like this. It will dissipate with distance, but unlike a drop of water on a pond, it will not move constantly outward like the wave on the surface of the water. Instead, magnetic flux travels around and around as if a pellet were dropped into a circular rim that tipped it around, allowing it to continually return to its place of origin.

When a magnetic field encounters MuShield's high permeability magnetic shielding material (aka Mu Metal or HyMu 80), the lines of flux are absorbed into the material like a sponge. A better analogy for this phenomenon is a beaver dam. When water hits a beaver dam, the water is keeping the inhabitants safe and comfortable. When we shield a sensitive instrument using high permeability magnetic shielding materials, the magnetic flux is absorbed and re-routed around the shield, keeping the instrument safe and operational.

Now, if the high flux density field is too strong for MuShield's high permeability magnetic shielding material, the shield will saturate. In this scenario, we would use a two-stage design with an outside layer of MuShield's medium permeability magnetic shielding material (depending on the magnetic field strength) to dilute the burst of dense magnetic interference. In this design the second layer would be constructed from MuShield's high permeability magnetic shielding material and would absorb the residual magnetic flux. This double shield allows us to protect from sudden and dense magnetic fields, as well as shield from strong residual magnetic shields.

Finally, when we succeed in shielding a component from magnetic interference, we have weakened the field to a measureable and desired degree. We call this the magnetic attenuation ratio. High attenuation (500X, 1000X, 2000X etc.) means lower magnetic interference (if any).

ELECTROMAGNETIC FREQUENCY RANGE TABLE

MUSHIELD RANGE: 3 - 40 kHZ

ELF	30 - 3,000 Hz
SLF/VF	300 - 3,000 Hz
VLF	3 - 30 kHz
LF	**30 - 300 kHz**
MF	300 - 3,000 kHz
HF	3 - 30 MHz
VHF	30 - 300 MHz
UHF	300 - 3,000 MHz

If it is not controlled, electromagnetic (EM) energy can cause interference in communication systems and create havoc with sensitive electronic equipment. In medical diagnostics equipment, electromagnetic interference (EMI) can cause false readings, and in rare cases, it may disrupt the proper operation of life-sustaining electronic devices such as kidney dialysis machines. EMI leakage commonly occurs around microprocessors and clock sources. It also leaks from transformers and small motors or power supplies. EMI is generated by nearly all electronic devices that require a power source. In most cases, EMI can be controlled with proper design and layout. The table to the left lists various frequency bands where EMI can occur.

MuShield specializes in VLF and LF (up to 50 kHz) magnetic shielding. Low frequency interference is characterized by long wave lengths, which, if not shielded properly (using high permeability materials), will propagate through traditional barriers (such as copper). If you require shielding in the range of 3-50 kHz, we can assist you with an appropriate shield design.

INSTRUCTIONS

DESIGNING A MAGNETIC SHIELD

Theoretically, magnetic shielding concepts are confusing enough. Theories become realities through geometry. Magnetic shielding is no different.

When designing a magnetic shield, you must first decide what to shield. In operation, a magnetic shield absorbs magnetic flux by providing a path around the sensitive area and protecting the electronics found within the magnetic shield. In addition, magnetic shielding may be used to contain magnetic flux from leaking out and causing other sensitive electronics to malfunction. A question you have to ask yourself is, "Is it more practical to shield the effected unit or the effecting unit?". From there, we can then begin to design your magnetic shield.

The **most** efficient magnetic shielding shape is a sphere constructed of MuShield's high permeability magnetic shielding, also known as Mu Metal. Unfortunately, spherical shells are highly impractical, so the next best magnetic shield shape is a cylinder with a 4:1 length to diameter ratio. The rounded surface of a cylinder is conducive to the absorption of magnetic flux.

When cylinders will not fit in your application and a box shaped magnetic shield is more practical for mechanical or structural reasons, fabricated sheet metal boxes are the next best choice. Bend radii should be as large as possible because the magnetic flux permeating through the magnetic shielding material does not turn on sharp edges easily and flux leakage can occur.

The **least** favorable magnetic shielding shape is a large flat sheet. Since a magnetic shield functions by providing a low reluctance flex path, and magnetic flux flows from its north pole to the south pole, a flat sheet will only cover a portion of the flux path. Additionally, as the angle of the magnetic field vector approaches perpendicular to the surface of a flat sheet, the magnetic shield's efficiency is severely reduced. This situation should be avoided.

Do you have a specific magnetic shielding design in mind and want to find out if it is not only an effective way to shield magnetic flux, but also if it is manufacturable? Contact the MuShield Company today at **info@mushield.com** or **603.666.4433**. One or our talented engineering staff will reach out to you about your specific magnetic interference problem and work with you to solve it.

INSTRUCTIONS

SELECTING MAGNETIC SHIELDING MATERIALS

HIGH, MEDIUM & LOW PERMEABILITY

When selecting magnetic shielding materials, there are several parameters which need to be considered. The most critical is determining the strength or flux density of the magnetic field to be shielded. Other factors such as shield geometry, required attenuation and mechanical stability are also important. Once the field strength has been determined, either by direct measurement with a gauss meter or by mathematical modeling, the appropriate magnetic shielding alloy can be selected.

The ability to conduct magnetic lines of flux is called permeability, and in a magnetic shield, the degree of permeability is expressed numerically. The standard is free space and that permeability value is **one**. In comparison, MuShield's magnetic shielding materials range in permeability from **200,000-350,000**. Knowing the permeability value of the magnetic shielding materials you are choosing from is imperative when selecting the proper materials for your magnetic shield.

For most magnetic shielding applications, MuShield uses high permeability magnetic shielding materials known throughout the industry as Mu Metal, Permalloy 80, Magnifier 79 or Hy Mu 80. These materials meet industry specs ASTM A753 Alloy Type 4 and MIL-N-14411 Composition 1, are the most readily available of all the magnetic shielding alloys and provides the highest permeability.

For magnetic shielding applications involving strong magnetic fields, (usually over 25 Gauss) and require a moderate amount of attenuation, a medium permeability alloy known in the magnetic shielding industry as Alloy 49, Hiperm 49 or Magnifier 49 is used.The aforementioned names all conform to spec A753 Alloy Type 2 or MIL-N-14411 Composition 3.

This material is used for stronger magnetic fields because while it has a lower maximum permeability than MuShield's high permeability magnetic shielding, the saturation induction of MuShield's medium permeability magnetic shielding is double that of the high permeability material. When saturation occurs in a magnetic shield, the permeability asymptomatically approaches one, which as mentioned earlier, is the permeability of free space. In other words, the magnetic shielding affect of the material no longer exists.

A common application for MuShield's medium permeability magnetic shielding material is in multi stage cylinders. The outside layer is made using medium permeability material, while the inside layer is made from MuShield's high permeability magnetic shielding materual with a minimum of a 1/2" gap between the two layers. If the high permeability material was used on its own, it would saturate due to the strong magnetic field. The medium permeability material is used to dampen the field, allowing the high permeability material to absorb the weakened field the magnetic shield was designed to block.

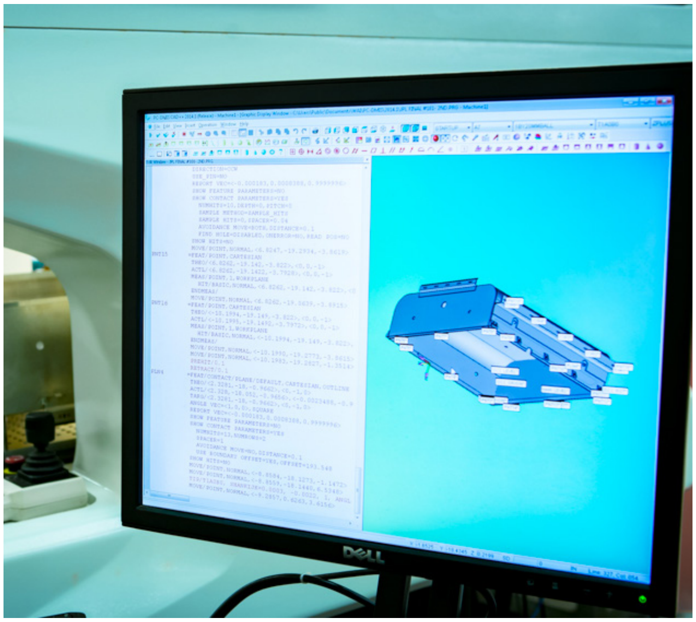
SELECTING MAGNETIC SHIELDING MATERIALS (CONT.)

In severe cases, low permeability materials such as low carbon steel or pure ingot iron can be used to reduce saturation. While these materials have low initial permeability, they exhibit a tremendous ability to withstand strong magnetic fields without saturating. Often times, medium or low permeability magnetic shielding materials are combined with the high permeability material, forming a multistage magnetic shield that can withstand flux densities that exceed 50 Gauss.

In some scenarios, there is a need for a magnetic shield that deploys all three types of materials. MuShield's high permeability magnetic shielding, medium permeability magnetic shielding and low permeability steel are used together to form a magnetic shield that yields significant attenuation of high flux magnetic fields. A magnetic shield used in this scenario would have the low permeability material closest to the field, the medium permeability material as the center material and then the high permeability material closest to that which is being shielded. Similar to the two stage design mentioned earlier, the magnetic shields should be insulated from each other with at least a 1/2" gap.

To wrap this up, the significant parameter to remember is a material's permeability. Permeability is the materials ability to align magnetically to the applied (ambient) magnetic field. It is expressed a ratio, comparing the material's molecular magnetic alignment caused by the applied magnetic flux field. Some of the materials mentioned earlier can be seen below:

Material	Initial Permeability Ratio
MuShield's High Permeability per ASTM A753 Alloy Type 4	80,000:1
MuShield's Medium Permeability per ASTM A753 Alloy Type 2	20,000:1
Low Permeability (Low Carbon Steel, Silicon Iron)	200:1



SELECTING THE PROPER MATERIAL THICKNESS

MATH BEHIND MAGNETIC SHIELDING

LEGEND

B = Magnetic flux density
d = Magnetic shield diameter or diagonal
t = Material thickness of magnetic shield
H_O = Ambient magnetic field
2.5 = Converting constant

Theoretically, a magnetic shield can be designed using a handful of simple algebraic equations. The following mathematical models are used to determine certain variables which are required to properly design magnetic shields. Parameters such as ambient magnetic field and desired level of attenuation must be determined as well as the size, shape and material thickness required. First, we will determine the magnetic flux the magnetic shield will absorb:

$$\mathbf{B\ (Gauss)} = \frac{(2.5)(d)(H_O)}{2t}$$

2.5 is a constant used to convert centimeters to inches, compensating for the answer in gauss which is in the cgs (centimeter, gram, second) units of measure.

In this equation, $\mathbf{H_O}$, the ambient magnetic field, has been determined by either direct measurement or mathematical modeling. The magnetic shield diameter or diagonal, **d**, is a mechanical design parameter required by the designer to house or enclose the item or space to be shielded. The thickness, **t**, is then selected so that the equation will result in a value for **B (gauss)** between 40 and 7,000, of which the most desirable outcome should be at or around 2,500. Once B is calculated, we use the **B-H Graph** (page 10) to find the permeability. For a DC value of 2,500 gauss, μ= 350,000. This is the maximum permeability for most high permeability magnetic shielding alloys and will yield dramatic magnetic field attenuation as calculated below.

$$\mathbf{Attenuation} = \frac{\mu t}{d}$$

Finally, to calculate the attenuated field ($\mathbf{B_S}$), use the equation:

$$B_S = \frac{H_O}{A}$$

EXAMPLE EQUATION

Refer to the example values in the table below:

VALUES	EQUATIONS
H_O = 5 Gauss	B_O = (2.5)(d)(Ho)
d = 4.5"	A = (u)(t)/d
t = .010"	B_S = H_O/A

$$B = \frac{(2.5)(4.5)(5)}{(2)(.010)} = 2{,}812.5$$

The B-H graph (see page 10) gives us μ = 275,000.

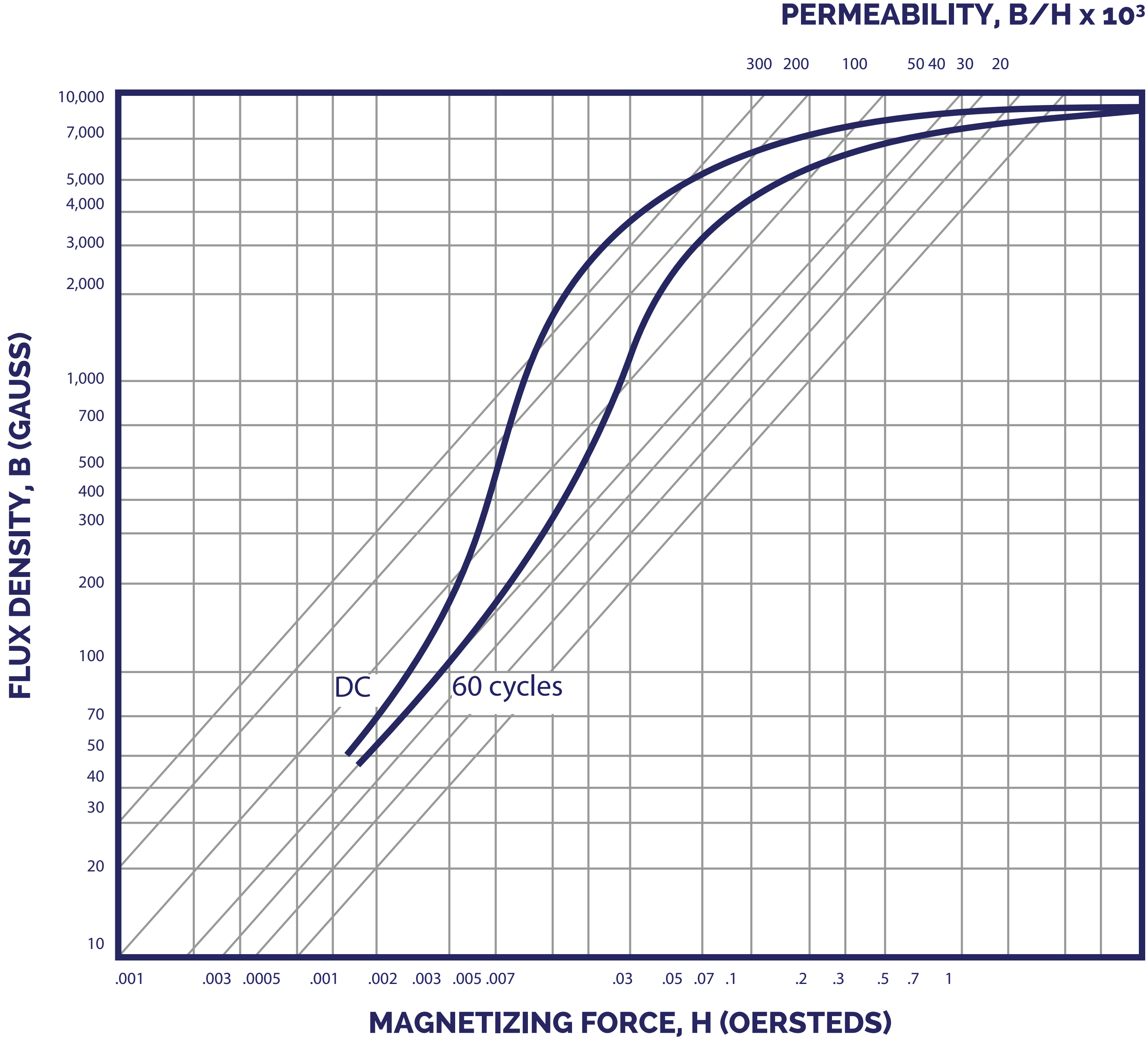
$$A = \frac{(275{,}000)(.010)}{4.5} = 611$$

These equations tell us the attenuation of the magnetic shield is 611, otherwise noted that the magnetic shield will reduce the ambient field (H_O) by 611 times. Mathematically:

$$B_S = \frac{5\ \text{Gauss}}{611}$$

HIGH PERMEABILITY MUSHIELD MATERIAL B-H GRAPH

HIGH PERMEABILITY MUSHIELD MATERIAL
PER ASTM A753 ALLOY TYPE 4 OR MIL-N-14411 COMPOSITION 1



INSTRUCTIONS

PROTOTYPING WITH HIGH PERMEABILITY MAGNETIC SHIELDING

Design engineers are often faced with mechanical design or magnetic interference problems requiring quick, effective and inexpensive solutions. When designing a magnetic shield, engineers can run into long trial and error periods, which can be expensive. Fortunately, that is where we can help you! Our engineers have extensive experience working with magnetic shielding foils and sheet stock. They have put together this Magnetic Shield Kit to help decrease your trial and error period.

In some cases, a high permeability magnetic shielding foil is all you need for a magnetic shield. In other cases, the high permeability magnetic shielding foil isn't strong enough, which indicates the need for either sheet stock or a fully fabricated custom magnetic shield.

MuShield's high permeability magnetic shielding foil is available in .004", .006" and .010" thicknesses and can be cut using scissors and formed by hand. Since it is easy to manipulate the foil into a magnetic shield, and the material is relatively inexpensive, a prototype can be made quickly and cost effectively. Generally, MuShield's high permeability magnetic shielding foils are used to make smaller magnetic shields. The flexibility and light weight features of the material could be troublesome when building larger magnetic shield prototypes. Common applications where we see our customers using the high permeability magnetic shielding foil is a simple 5-sided box designed to fit over a small transformer or printed circuit board.

For magnetic shield prototypes where the foil may show little to no shielding effect, we would suggest using our high permeability magnetic shielding MuShield's high permeability magnetic shielding sheet stock found in this Magnetic Shield Design Kit. High permeability sheet is available .014", .020", .025", .030", .040", .050", .062", .080" and .125" thick and sheets start at 24"/30" x 120" long, but can be cut to whatever size you need. For prototyping purposes, you will need a shear, laser or water jet for cutting and a mechanical press brake or some other roll forming machine to bend the sheet stock.

Using MuShield's high permeability magnetic shielding foil or sheet stock material as a first pass prototype may be a quick and effective way to test a magnetic shield design, but if more extensive magnetic shielding is needed, don't hesitate to contact us at **info@mushield.com** or **603.666.4433.**

HEAT TREATING MAGNETIC SHIELDING MATERIALS

When MuShield's high permeability and medium permeability magnetic shielding are produced, the materials are put through stringent measures to assure the purity of each alloy. The alloying elements are blended in molten form in a vacuum. This vacuum environment prevents carbon and oxygen inclusions, keeping the magnetic shielding alloy pure.

While the melting process is kept as pure as possible, the magnetic shielding material still has a lot of stress put into it during cold working fabrication processes. As a final operation before it is a finished (and effective) magnetic shield, MuShield's magnetic shielding materials need to be heat treated to restore maximum magnetic permeability. Like the vacuum melting process, the heat treat process must also keep the alloy pure to optimize magnetic shielding performance. We use a hydrogen retort furnace for all of our in-house heat treating, which allows us to insure quality and maximum permeability for all of the magnetic shields we produce. Vacuum heat treating will also yield similar results and is used at times for larger magnetic shields.

When hydrogen heat treating our magnetic shields, the temperature inside the retort exceeds 2100°F (1150°C) and the shields are held at temperature for 1-4 hours, dependent on the application. This temperature is the grain growing temperature for all high permeability magnetic shielding alloys, as the material is nearly molten at this temperature and the crystalline structure of the material reorders itself into large grains. The result of the enlarged grains is increased permeability (aka magnetic shielding effectiveness) of the material.

Along with the grains growing, the hydrogen flowing through the retort attracts any carbon or oxygen molecules found on the surface of the material that could interfere with the grain structure. The newly formed hydrogen-carbon or hydrogen-oxygen molecules then flow out with the exhaust hydrogen gas and are burned off as the hydrogen exits the retort.

A simple way to make sense of the hydrogen heat treating process; look at it as purifying the magnetic shielding materials by cleaning out the grains. The enlarged grains in the material can be thought of as pockets for the magnetic flux to be absorbed into. The bigger the pocket, the more magnetic flux that can be absorbed.

Even at the extreme temperature we heat treat our magnetic shields, the structural integrity of the shield is not compromised, though material will be significantly softer (increased malleability) coming out of the furnace and you may see some slight warping of the material due to the extreme heat. Careful post heat treat sizing of our magnetic shields is not uncommon. All of this is taken into consideration when our Sales and Application Engineers are working with you to design the ideal magnetic shield for your specific application.

It should also be noted that heat treating should be the **final** process in the fabrication of any magnetic shield and that all magnetic shields should be handled with care. Any additional work done to the material or impact can degrade its magnetic shielding abilities. Our in-house hydrogen heat treat process is the most cost effective way in which to maximize magnetic shield permeability.

HEAT TREATING VS ANNEALING

Often times we receive requests for us to "Hydrogen Anneal for Maximum Magnetic Permeability". While we understand what our customer is looking for, we try to educate them about the difference between "Annealing" and "Heat Treating".

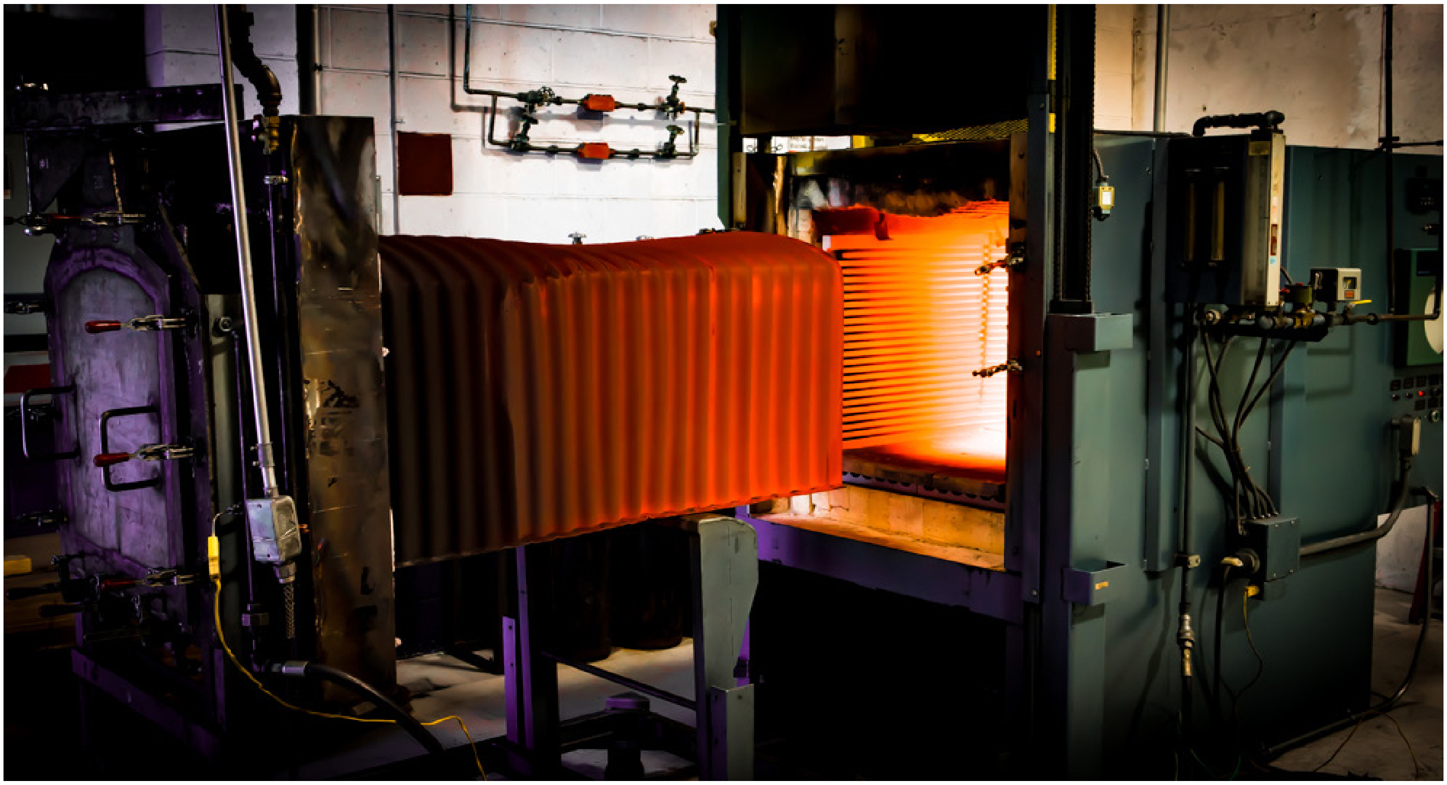
The definition of **annealing** is **"heat metal and allow it to cool slowly, in order to remove internal stresses and soften it."** While we may need to anneal our magnetic shielding alloys during the fabrication process, we do not anneal for **maximum** magnetic permeability. As noted in the definition, the annealing step is done to relieve stress within the material that was introduce as a part was being formed or bent.

When we are **heat treating** our magnetic shielding materials, we are actually changing the physical properties by enlarging the grain structure, allowing for more magnetic flux to be absorbed by the magnetic shielding.

In conclusion, both **annealing** and **heat treating** are necessary during the magnetic shield fabrication process, but both serve a very different purpose. If you need to relieve stress in material, you want to **anneal** it. If you are trying to achieve maximum permeability, you want to **heat treat** the material.

Also, it should be noted that material in our kits have been annealed for forming, but not heat treated for maximum magnetic permeability.

If you still have questions about heat treating and annealing, do not hesitate to contact us at **info@mushield.com** or **603.666.4433** with any specific questions.



TECHNICAL FEATURE

HYDROFORMING & ITS VALUE TO MAGNETIC SHIELDING

In the early 1950's, automotive companies started realizing the benefits of sheet metal hydroforming. Previously using expensive punch and die sets for their stamping needs, these companies were able to create the same deep draw designs and saved a considerable amount of money due to less demanding tooling needed for the hydroform process.

Eventually, hydroforming found its way into the aerospace and defense industries as companies utilized this niche process to create formed parts that were once fabricated or spun. MuShield, once an industry leader in metal spinning of magnetic shields, recognized the benefits of hydroforming from a cost and magnetic shielding standpoint and brought a 12" Cincinnati Hydroform press onto the manufacturing floor in 2010.

A hydroform machine utilizes a forming punch machined to the inner dimensions of the desired sheet metal part and can make both simple and complex sheet metal shapes. Hydraulic pressure (up to 15,000 PSI) behind a specialized rubber diaphragm provides the force required to wrap sheet metal material onto the punch as drawing force and motion is applied. **The resulting large radii on the finished part is preferred from a magnetic shielding standpoint because the magnetic flux permeating through the magnetic shield turns easily on large radii and eliminates any chance for flux leakage.**

Tooling cost is minimized since one or two form punches are required for most piece parts. Each form

tool will last the life of the part because a hardening process is performed after the form tool has been proven out. You will see dimensional consistency from part to part and production run.

Hydroforming can also be cost effective when comparing it to a fabricated part. For most hydroformed parts, the production steps are as follows:

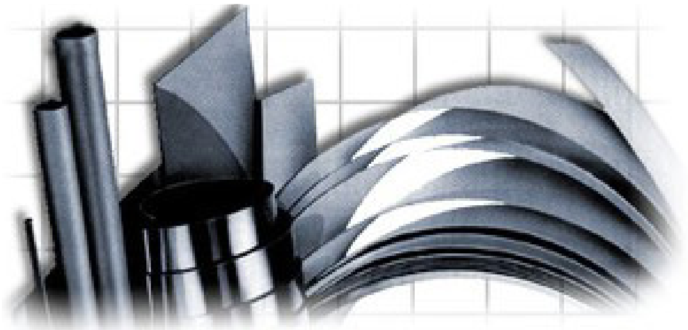
1. One to two forming operations
2. In-process anneal
3. Laser cut any details, cut outs or excess material

While MuShield specializes in hydroforming magnetic shielding materials, we are not limited to just those. We hydroform material such as Stainless Steel, Brass, Aluminum, Inconel and other alloys on a daily basis. If you have a design that you think would be a good fit for our hydroform, do not hesitate to contact us at **info@mushield.com** or **603.666.4433** to discuss your application further.

(Example of a hydroformed part from flat blank to in-process part to final hydroformed part with laser cut details.)

MAGNETIC SHIELDING MATERIAL

The designation for magnetic materials can be confusing, but we are here to make it easier for you. For years, the materials used primarily for magnetic shielding purposes were designated using military spec MIL-N-14411. That spec has since been retired and replaced with the ASTM A753 spec. Below is a side by side breakdown of each spec and materials available at MuShield.



ALLOY TYPES

ASTM A753 Alloy Type	MIL-N-14411 Type	UNS Number	Nickel Range %
2 (Medium Permeability)	Composition 3	K94840	47.0-49.0
3 (High Permeability)	Composition 2	N14076	75.0-78.0
4 (High Permeability)	Composition 1	N14080	79.0-82.0

CHEMICAL COMPOSITION

	Alloy 2/Composition 3 (Medium Permeability)	Alloy 3/Composition 2 (High Permeability)	Alloy 4/Composition 1 (High Permeability)
Carbon, max	0.05	0.05	0.05
Manganese, max	0.80	1.50	0.80
Silicon, max	0.50	0.50	0.50
Phosphorus, max	0.03	0.02	0.02
Sulfur, max	0.01	0.01	0.01
Chromium, max	0.30 max	2.00-3.00	0.30 max
Nickel	47.00-49.00	75.00-78.00	79.00-82.00
Molybdenum	0.30 max	0.50 max	3.50-3.60
Cobalt, max	0.50	0.50	0.50
Copper	0.30 max	4.0-6.0	0.30 max
Iron	Balance	Balance	Balance

MAGNETIC SHIELDING MATERIAL (CONT.)

MUSHIELD'S HIGH PERMEABILITY MAGNETIC SHIELDING

High permeability magnetic shielding material used for high attenuation of low flux density magnetic fields with an 80% nickel content

Per ASTM A753 Alloy Type 4 and MIL N 1441C, Composition 1

Per ASTM A753 Alloy Type 3 and MIL N 1441C, Composition 2 (Seamless tubing and some forgings only)

Forms Available	Thickness (inches)	Width (inches)	Length (inches)
Coil	.002", .004", .006, & .010"	Up to 15"	per foot
Sheet	.010", .014", .020", .025", .030", .040" .050", .062", .080", & .125"	Up to 30"	up to 120"
Plate & Forgings	.130" and up	10" max	per foot
Round Bar & Wire	-	.005" - 4.50" (dia)	per foot
Seamless Mu Metal Tubing	-	.080 (min)/2.625" (max) OD	per foot

MUSHIELD'S MEDIUM PERMEABILITY MAGNETIC SHIELDING

Medium permeability magnetic shielding material used for a combination of high attenuation of medium flux density magnetic fields.

Per ASTM A753 Alloy Type 2 and MIL N 1441C, Composition 3 (Coil and Sheet Stock)

Forms Available	Thickness (inches)	Width (inches)	Length (inches)
Coil	.010"	Up to 12"	per foot
Sheet	.020", .040", & .062"	Up to 24"	up to 120"
Bar	-	Call for availability	-

CRYOPERM (not included in the kit)

High Permeability cryogenic magnetic shielding material. Used for high attenuation of low flux density magnetic fields in a cryogenic atmosphere (4.2k) with an 80% nickel content

Forms Available	Thickness (inches)	Width (inches)	Length (inches)
Coil	.020" & .040"	up to 13"	per foot

MAGNETIC SHIELDING MATERIAL (CONT.)

MECHANICAL PROPERTIES (STRIP)

	Cold Rolled	As Hydrogen Annealed at 2050°F (1,121°C)	After Process Anneal at 1600°F (1,121°C)
Tensile strength, ksi	135	77	98
MPa	931	531	676
Yield point, ksi	-	21	38
MPa	-	145	262
Proportional limit, ksi	-	15	35
MPa	-	103	241
Elongation %	4	38	38
Rockwell B hardness	100	58	85

WORKABILITY - COLD FORMING

• It is suggested that strip material with a Rockwell B 90 minimum hardness be used when blanking material.
• When forming, material should be in the cold rolled mill annealed condition.
• When drawing, material should be in the deep drawn mill annealed condition.

CORROSION RESISITANCE

While you can nickel plate MuShield's High Permeability Magnetic Shielding materials for additional corrosion resisitance, it is not required. The bare material's resistance to moisture within the atmosphere is sufficient in most applications.

WHAT'S NEXT?

If the material supplied in the kits has solved your magnetic interference problem, great! Send us a drawing of the final design and we can quote a production order. We are a worldwide distributor of magnetic shielding materials and fully fabricated shields. If you have a need for a larger or more robust magnetic shield than what the kit materials can offer, MuShield will gladly work with you on a design that will solve your magnetic interference problem! Visit our website at **www.mushield.com**, email us at **info@mushield.com** or call us at **603.666.4433** to get the conversation started. We have a talented sales and engineering staff at your disposal.