NPT Threads Technical Manual

Contents

One of the least understood, and most challenging areas in modern machine shops is the production of tapered pipe threads. Very few machine operators understand how the thread is intended to work, let alone the varied challenges in creating these threads in different materials and applications.

This manual provides an overview of NPT threading and the variety of tools and process available to create this thread type.

NPT Threading Solutions

Tooling Options:

Tap

The oldest option is still one of the best.

Usually fastest cycle time.

Has significant disadvantages when dealing with strong long chipping materials

Skip Tooth Tap

Skip tooth taps can work well in long chipping difficult materials, where standard taps have been shown to fail.

Required torque is reduced.

Usually not recommended when using a pre tapered hole.

Full Form Thread Mill

Thread milling is becoming the go to solution for producing NPT threads in difficult to machine materials, including many alloys common in aerospace.

The downside is thread milling can take slightly longer for cycle time.

Single Plane Thread Mill

A single plane thread mill can sometimes be necessary if the machine does not have a spindle capable of dealing with the high radial forces needed for full form thread milling. Or if the tool holding solution is less than ideal.

Again, this option takes longer.

Insertable Thread Mill

Our insertable Gigantic system is great for if you have a need to create a large NPT thread in a relatively small CNC machine.

The inclusion of full profile NPT thread inserts allow the Gigantic system to machine the required 100% thread height of the NPT thread form.

Tried and true. Using a tapping strategy is the original tooling option for making NPT threads. In many cases a basic full profile tap is the best option for a tapered thread application.

Pros

Quick- tapping cycles are usually the fastest way To generate an NPT thread.

Easy- Everyone running a machine tool will know how to program a tapping cycle. (or at least they should)

Accessible- NPT taps are available at almost any cutting tool manufacturer.

Cons

Torque- Running a tapered tap requires quite a bit more horsepower than a standard straight thread tap, of similar size.

Chip Control- Due to the high amount of material a tapered tap needs to remove from the prepared hole, chip clogging is a very real hazard.

Material- When dealing with the more difficult to machine materials, especially modern high temp alloys common in aerospace, a tap option will not be capable of making the thread.

Basic Upgrade. If you want to use a tap for your NPT application, but you are running into chip control issues. **Skip Tooth Taps** can sometimes provide some relief

Pros

Same- The basic advantages of using a tap apply to a skip tooth design as well.

Drag- By reducing drag skip tooth designs can help to alleviate some of the torque load when removing the excess material from the tapered thread form.

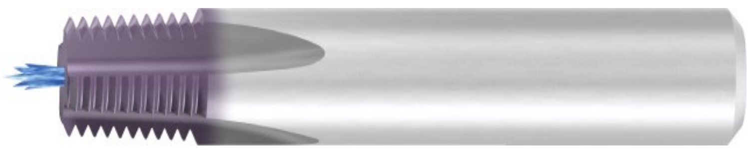
Cons

Chip Control- Due to the high amount of material a tapered tap needs to remove from the prepared hole, chip clogging is a very real hazard.

Material- When dealing with the more difficult to machine materials, especially modern high temp alloys common in aerospace, a tap option will not be capable of making the thread.

Availability- Compared to traditional taps, skip tooth designs are less common, and can be more expensive than the lower tech counterparts.

In many applications an NPT thread needs to be machined into a material that is just too difficult to run a tap in (titanium or many High Temp alloys). In this case a **Carbide Thread Mill** is your only option.



Pros

Range- By turning to an interrupted cutting process such as milling, we uncouple the cutter from the massive torque load necessary to cut the NPT thread in one long continuous cut. Meaning you can make a large NPT thread using a significantly smaller machine.

Chip Control- Because thread milling is an interrupted cutting process, it produces small easily controlled chip shapes.

Material- When dealing with the more difficult to machine materials, especially modern high temp alloys common in aerospace, thread milling will be the only option capable of making the thread.

Cons

Speed- Compared to tapping options, thread milling the NPT form is almost always a longer cycle time.

Deflection- Because of the radial pressure involved with the spiral interpolation of the cycle, only extremely strong rigid tool holding solutions will work effectively. NO ER COLLETS.

Single Plane Thread Mill

In some cases, the need to cut an NPT thread using an ER collet cannot be avoided. This is when a single plane thread mill would usually be recommended. By reducing the axial length of engagement on the tool down to one pitch of thread, we gain a high degree of stability on top of the normal benefits of thread milling.

This is also useful when making a thread in a particularly difficult material. Cycle time will be increased, but process reliability will be increased as well.

Important!

Because the single plane thread mill is not designed to cut at the crest of the thread, the minor diameter MUST be tapered to the NPT specification before utilizing this option.

Single Plane / Insertable

Taking the benefits of the single plane thread mill one step further. A final option for cutting tapered threads, is an insertable thread mill type cutter. Such as the Emuge Gigantic.

The Gigantic thread milling system combined with an NPT full profile insert design, which helps alleviate burrs and minor inconsistencies on the produced thread crest. This insert can eliminate the need to have a large high torque machine to create large NPT threads.

Important!

Because the single plane thread mill is not designed to cut large amounts of material at the crest of the thread, the minor diameter MUST be tapered to the NPT specification before utilizing this option.

Cylindrical Hole

The first step to creating an internal NPT thread is a cylindrical hole.

Whether you are planning to produce your thread with a tap or thread mill, and whether you plan to cut the thread into the cylindrical hole or save wear on your threading tool by preparing the taper before threading. The first step must by necessity be producing the hole.

Hole Prep

Hole Making Strategies

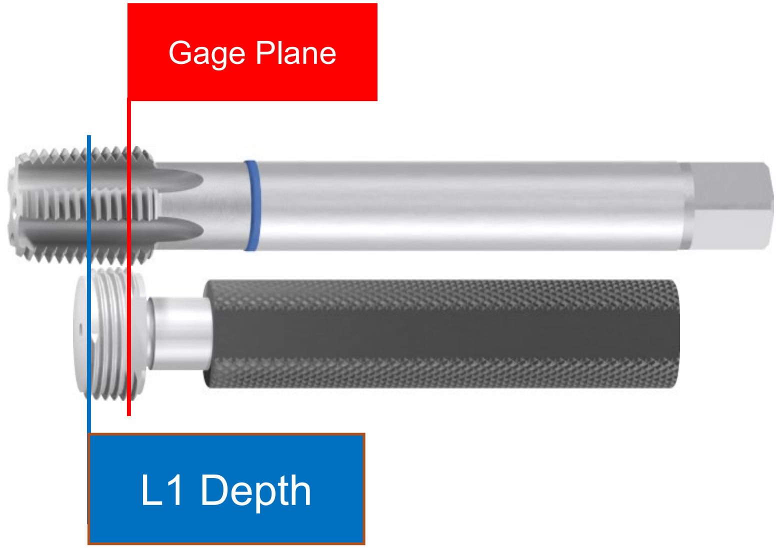
Three NPT thread hole making strategies:

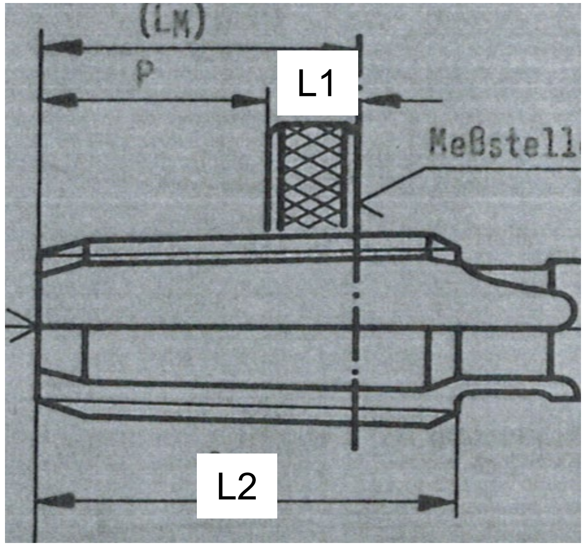
- 1 - **Drilling**
  Assuming you have a machine which can handle the torque required of a drill the diameter needed for your NPT thread size, this is the quickest, and normally the most efficient option for creating your hole prior to threading.

- 2 - **Helical Interpolation**
  If you are in a smaller machine attempting to make a larger NPT thread you will find that due to the greater torque required to turn a drill, your best option will probably be to opt for a smaller diameter straight end mill. Which can then be programmed to helically interpolate for a hole-making cycle. Then circle milling out to the required diameter.

- 3 - **Combination**
  A third option would be to combine the first two into two stage operation. By using a smaller drill diameter, just large enough so that you can plunge an endmill of sufficient cutting length to achieve the needed hole depth you can quickly and efficiently achieve larger hole diameters in smaller machine tools.

Projection Length





The basic “useable thread” called for by the NPT standard is longer by several turns than the actual portion of the thread which will be gaged (L1) dimension. In many cases this fact will be used by engineers to call for a “short projection” NPT. Particularly in tight spaces or thin-walled components.

Short Projection taps are available as a modified standard or complete special.
Contact Emuge at www.emuge.com with the minimum drilling depth requirement to determine the best solution.

Important Note

The following pages will explain what dimensionality you will need to prepare holes to properly cut your NPT thread given your specific choices of tooling. This assumes the following:.

The first assumption is that the goal is to produce a thread to the basic NPT engagement length.

The second is that that the selected tap has a standard 2-3 pitch cutting chamfer.

If this is not the case and you are dealing with a modified tap or thread.
Contact your local Emuge sales engineer or Technical@Emuge.com for additional support.

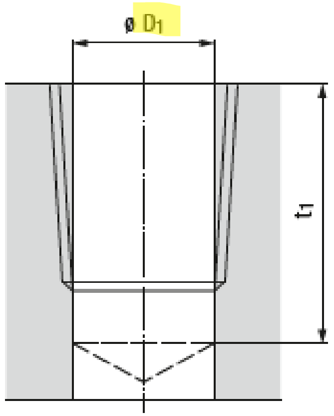
Recommended Hole Diameters

The recommended diameter of your cylindrical hole will change dependent upon whether you plan to thread the hole from a straight cylindrical or whether you plan to apply the NPT 1° 47’ 20” taper to the hole prior to threading.

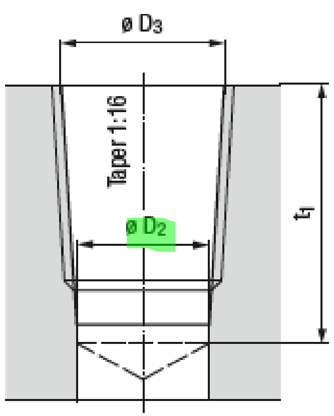
Please Note- In the below chart the D1 dimension refers to the recommended diameter for the straight cylindrical hole, the D2 dimension is the recommended drilling diameter if you intend to add the taper to the hole prior to threading.

Thread Hole Preparatory Diameters for Tapered Pipe Thread NPT, Taper 1:16

A) Cylindrical preparation of thread hole

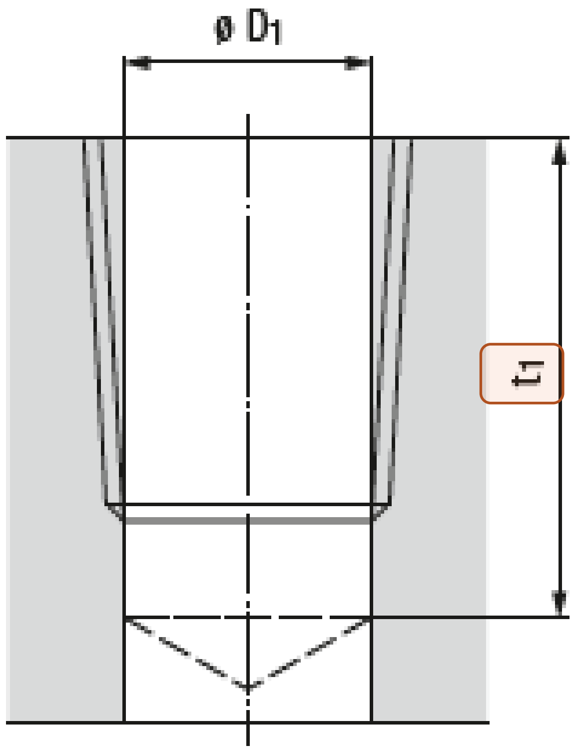


B) Tapered preparation of thread hole



Nominal Size ø d_1	T.P.I.	ø D_1 inch	ø D_2	ø D_3 (+0.002)	t_1
1/16	27	0.2421	0.2343	0.2516	0.4646
1/8	27	0.3346	0.3268	0.3441	0.4685
1/4	18	0.4331	0.4232	0.4472	0.6850
3/8	18	0.5669	0.5571	0.5827	0.6969
1/2	14	0.7008	0.6870	0.7213	0.9094
3/4	14	0.9114	0.8976	0.9319	0.9291
1	11 1/2	1.1437	1.1280	1.1689	1.1181
1 1/4	11 1/2	1.4882	1.4705	1.5138	1.1378
1 1/2	11 1/2	1.7264	1.7106	1.7528	1.1378
2	11 1/2	2.1988	2.1831	2.2268	1.1535

Drilling Depth – Taps

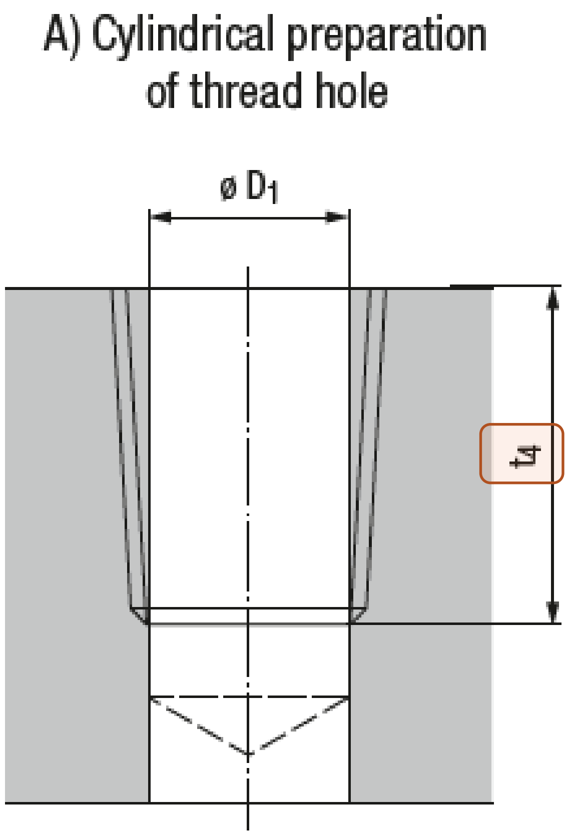


Nominal Size ø d_1	T.P.I.	t_1
1/16	27	0.4646
1/8	27	0.4685
1/4	18	0.6850
3/8	18	0.6969
1/2	14	0.9094
3/4	14	0.9291
1	11 1/2	1.1181
1 1/4	11 1/2	1.1378
1 1/2	11 1/2	1.1378
2	11 1/2	1.1535

The T1 dimension is referring to the **minimum safe depth** for the prepared hole diameter, specifically when using a standard projection length tap, with typical Form C style cutting chamfer.

This is the minimum drill depth to full diameter to create enough room to make the NPT thread with a conventional **TAP**.

Drilling Depths – Thread Mills



Nominal size ø D	T.P.I.	t_4
1/16	27	0.3268
1/8	27	0.3268
1/4	18	0.4783
3/8	18	0.4902
1/2	14	0.6417
3/4	14	0.6417
1	11 1/2	0.7697
1 1/4	11 1/2	0.7894
1 1/2	11 1/2	0.7894
2	11 1/2	0.8051

The T4 dimension, is the minimum depth of the full diameter for the prepared hole when **THREAD MILLING**.

This differs from the previous T1 dimension because when you are using a milling strategy there is no need to have a cutting chamfer on the tool. In this way we reduce the need to drill quite as deep for the application.

Creating Tapered Holes

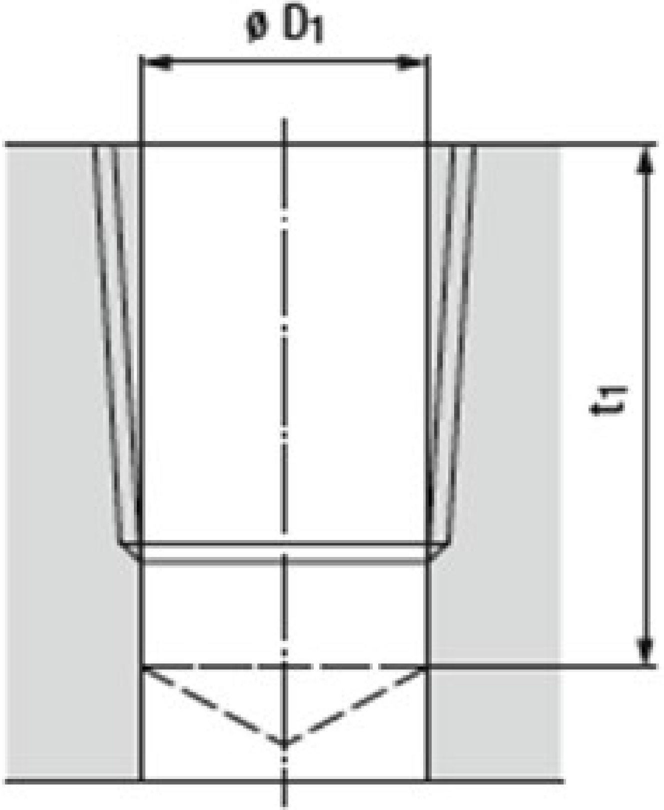
There are a couple of reasons to create an NPT 1/16 taper in a pre-drilled hole (D_1) prior to threading.

When Tapping:

Adding an additional machining operation prior to tapping an NPT thread will significantly increase the tool life of the tap and reduce the chip volume – preventing chip jamming.

When Thread Milling:

NPT threads created by thread milling *require* the creation of a tapered hole prior to thread milling in order to prepare the minor diameter of the thread.



Option 1
Tapered Reamer

A tapered reamer is a viable option if the machine has enough torque to turn the tool.

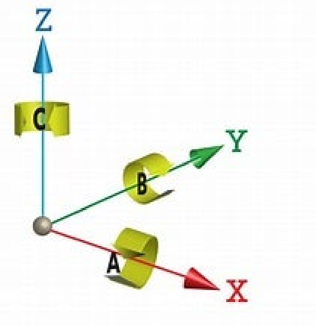
It is not an option in work hardening materials or high tensile materials that reamers are ineffective machining.

Depending on what tool you are using you may need additional drilling depth to achieve the proper minor diameter.

Option 2
Milling Interpolation

NPT Conical End Mill

Milling the taper with a
3-Axis Machine



The Emuge **NPT Conical End Mill** is an end mill design with the proper taper angle ground into the conical form.

Using a conical end mill, a relatively smaller machine tool we can prepare the minor diameter of some of the largest NPT sizes.

Part Number	Size
3914A.037020	3/8" NPT Tapered Carbide End Mill
3914A.050020	1/2" NPT Tapered Carbide End Mill
3914A.075030	3/4" NPT Tapered Carbide End Mill

For detailed application instructions for using the

New NPT Conical End Mill, please contact the

EMUGE-FRANKEN Technical Team at

800-323-3013 or email technical@emuge.com