<u>Hole sizes !</u>

By: ***Roy Vaillancourt***

Let's say while working on your latest bird you require a clearance hole for a machine screw. Ever wonder how you could figure out the diameter of the screw and its clearance hole without having to measure the screw or look things up in a chart? Well the size of the screw's major diameter is determined by a very simple formula. Just write this down on one of your work cabinet doors and you'll be able to figure out any screw size from a no 1 up to a no 12.

Here's the formula: Screw Dia = (it's size no. multiplied by .013) + .060
That is… Screw Dia = (no. X .013) + .060

So….. for a 4-40 screw it's major dia is (4 X .013) + .060 = .112
for a 2-56 screw it's major dia is (2 X .013) + .060 = .086 and so on…..

If you do not have a clearance hole chart, and need to know the clearance, just add 3X the screw size in number (in thousandths).

Examples:
A clearance hole for a no 2 screw would be .086 + (3X .002) = .092 (use .093 drill)
A clearance hole for a no 4 screw would be .112 + (3X .004) = .124 (use .125 drill)

After all the calculations just use the nearest standard drill to the final number. Hope you find this relatively simple and useful.

Just in case you're too lazy to figure things out, here's a simple chart…….

Screw size	**major diameter**	**clearance hole**	
2	.086	.092	(use .093 = 3/32)
4	.112	.125	(use .125 = 1/8)
6	.138	.156	(use .156 = 5/32)
8	.164	.188	(use . 187 = 3/16)
10	.190	.210	(use .203 = 13/64 ***OR*** .218 = 7/32)
12	.216	.246	(use .250 = 1/ 4)
Fraction sized screws would use the following:			
1/ 4	.250	.281	(use .281 = 9/32)
5/16	.312	.328	(use .328 = 21/64)
3 / 8	.375	.390	(use .390 = 25/64 ***OR*** .406 = 13/32)

Basically the above information comes from the ASME. ***American Society Of Manufacturing Engineers***. It has been derived from many years of study of various manufacturing techniques and situations. ***The Machinist Handbook*** also has data on this…

BUT… to explain where some of it comes from here goes.

IF you only had a "single hole" application like putting a single washer on a single bolt then you are most certainly able to make the clearance hole as tight to the screw as possible but in the assembly and manufacturing world there are various situations that call for different solutions.

For example: on screw charts for assemblies we have three applications:

1) Single hole… where the clearance hole is in a plate that needs to be affixed to a "base" part.

2) Multi holes in a machined part…. Where the clearance holes are in a plate or part that will be attached to a base plate or another part or two….

3) 3) Multi holes in a sheet metal part.

In (1), the single hole in the base plate and the attaching plate are pretty easy to line up… (kind of like the prop washer on the front of your engine.). But, if the top plate must line up with an edge or edges of the base plate then the tolerances of the hole locations in BOTH parts must be accounted for in TWO directions. (X and Y axis etc). Now if the hole in the base plate is a threaded hole then things get worse as the screw will not "float" in this hole… but the hole in the top plate must take up the manufacturing tolerances for both pieces.

In (2), you have the same problems as (1) except you have more of them….. So the clearance holes for multi hole machined parts are even greater. We as modelers tend to be a little anal when locating holes as we are usually only building one airframe. But in the real world of mass produced parts this tolerance issue has many ramifications… so the holes are big enough to accommodate all possible tolerance situations for many parts coming together from various vendors using many different manufacturing techniques…Naturally these tolerance must take care of all parts and must also assume that some of these hole locations will have threaded holes etc.

In (3), we have the worst possible situation. As sheet metal parts sometimes have their holes put in before any bending or forming is done. Talk about wide tolerances… This is the place for all sots of dimensions to vary from the original design intent (and on many different planes). So in sheet metal parts the clearance holes get even larger…. Check out car fenders and the "fender washers" used…. The fender has a big hole for floating and alignment while the washer is a nice snug fit to the fastener….

Now to add to all of this for ALL applications there is the tolerance of the actual hole(s). In the industry most "drilled" hole tolerances are +.006/ -.003 for the hole size. Except, naturally, when the hole gets real small (like for a no 4 screw etc).. This size tolerance applies to single hole machined parts and multi hole machined parts. This assumes that all the holes are either drilled or bored to size…. And done on a machine tool so locations are controlled pretty good….But, if we drilled the hole locations with a hand drill then all bets are off (even the size will vary from hole to hole using the same drill)…. AND THEN, when it comes to sheet metal parts all the rules change again. A standard sheet metal hole may have a +.020/-.005 tolerance applied to its size. In sheet metal we do not care how the hole is made. We just want a hole there. So the hole can be drilled, bored or punched…… (or any other manufacturing technique can be used to “make a hole”). Punching will make a nice hole but its edges and size will be a bit rough compared to the machined parts.

So…. My little chart is just the tip of the iceberg and is only used as a good starting guide for the average Joe Modeler to pick the right drills etc for his application and still assure him that things will go together. These are not just my thoughts. this is the way the manufacturing industry has been since WWII. These methods were put into place so that we could produce large quantities of war materials while using various vendors all across the country with all sorts of manufacturing techniques. It also assured that any plane, truck, jeep etc could be maintained anywhere in the field with minimal tools and assembly techniques.

Hope this explains some things and you found it interesting and helpful….