

White Dwarf Combustion Chamber Manufacturing Process

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1 Copper Cooling Jacket

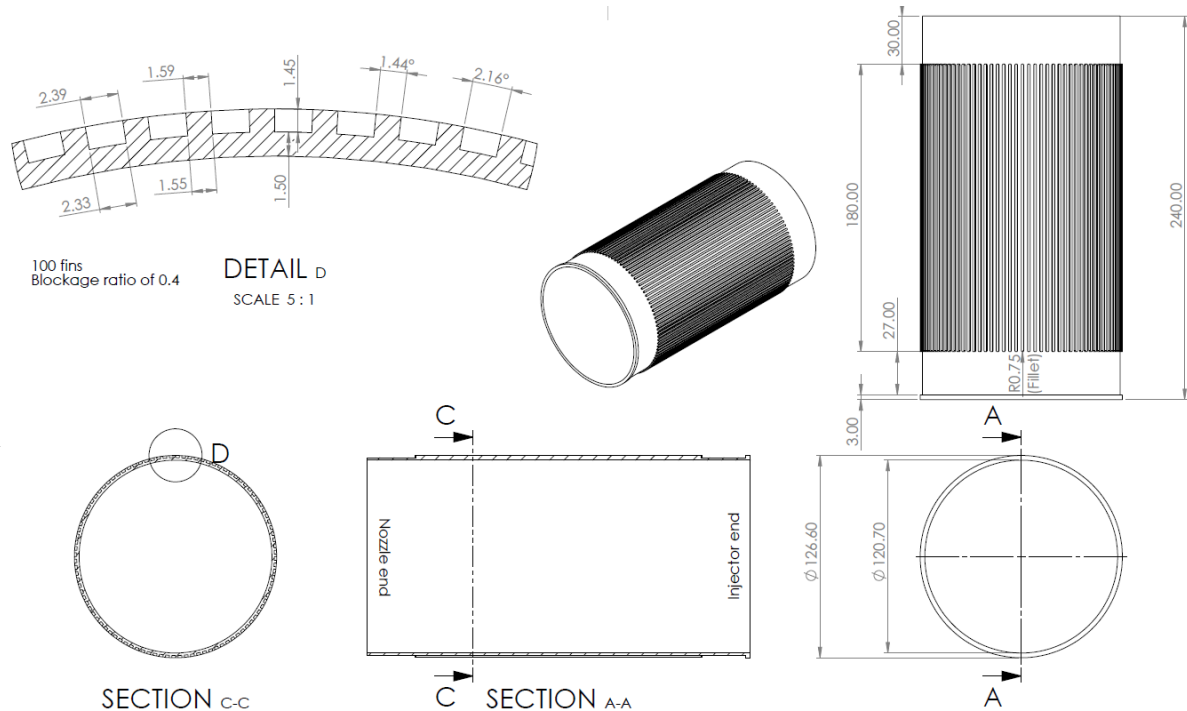


Figure 1: Engineering drawing for the White Dwarf copper wall, showing the cooling channels that are milled. The CAD was submitted as a .STEP file to the CNC machinist.

The combustion chamber is manufactured in the following steps:

1. Purchase a standard size copper tube with the desired OD. These usually come in standard imperial sizes (e.g. 4", 5", 6 3/4", etc.). Order the thickest tube available. This is usually 10 swg (3.251 mm). The tube for White Dwarf was purchased from [M-Machine Metals](#).

Tube	Copper	C106	3" OD x 14swg	£2.42	inch/25mm	£2.90
Tube	Copper	C106	3" OD x 10swg	£3.75	inch/25mm	£4.50
Tube	Copper	C106	3 1/4" x 16swg	£3.28	inch/25mm	£3.94
Tube	Copper	C106	3 1/4" x 10swg	£4.60	inch/25mm	£5.52
Tube	Copper	C101	90mm OD x 60mm ID	£20.54	inch/25mm	£24.65
Tube	Copper	C101	3 3/4" x 2" ID	£25.00	inch/25mm	£30.00
Tube	Copper	C106	4" x 10swg	£6.50	inch/25mm	£7.80
Tube	Copper	C106	4" x 16swg	£5.40	inch/25mm	£6.48
Tube	Copper	C101	4" x 2 3/4" ID	£22.20	inch/25mm	£26.64
Tube	Copper	C106	4 1/4" OD x 10swg	£7.00	inch/25mm	£8.40
Tube	Copper	C106	4 1/2" OD x 13swg	£7.00	inch/25mm	£8.40
Tube	Copper	C106	5" OD x 10swg	£8.75	inch/25mm	£10.50
Tube	Copper	C106	5 1/4" OD x 10swg	£9.00	inch/25mm	£10.80
Tube	Copper	C106	6" OD x 10swg	£17.00	inch/25mm	£20.40
Tube	Copper	C106	6 3/4" OD x 10swg	£21.50	inch/25mm	£25.80

Figure 2: Extract from the copper tube section of the M-Machine Metals catalogue.



Figure 3: Stock piece of copper used for White Dwarf, before having any machining done. This is a 5" OD, 10 swg tube, material C106 copper.

2. Use increasing fineness of sandpaper to smooth down the inside of the tube, and then polish it (e.g. with Brasso). **Do not attempt to lathe down the inside, there will be too much vibration and you will obtain a very rough finish and/or deep scratches.**



Figure 4: Copper tube after being polished. You can notice a visible scratch on bottom of the right hand image (red arrow), which is from our attempt to lathe out the inside. This scratch was difficult to remove and was simply polished later until smooth to feel.

3. The outside of the copper tube is lathed down to a constant outside diameter. This was done by the Whittle Lab technicians for White Dwarf. Try to take off as little material as it possible.
4. The cooling channels and final shape are cut out by a CNC milling machine. Two ‘top hats’ must be made to clamp either side of the copper, so it can be held by the CNC machine. These were made out of aluminium billets for White Dwarf, and were manufactured by the Whittle Lab technicians. A rod is driven through the two aluminium top hats, to clamp them together. Care must be taken not to clamp the copper too hard, to avoid buckling it.



Figure 5: Copper channels being milled into the outside of the tube (left), and the finished combustion chamber wall (right).

1.1 Feedback from Machinists

- Job did not take long, maybe 5-6 hours.
- The minimum wall thickness (1.5 mm) was not an issue. They wouldn't recommend going below 1 mm.

2 References

There are no sources in the current document.