# Wobbly on Exhaust Port Duct Design

This documents the current state of the art in exhaust port duct design. It assumes a high specific output engine with a modern type exhaust system.

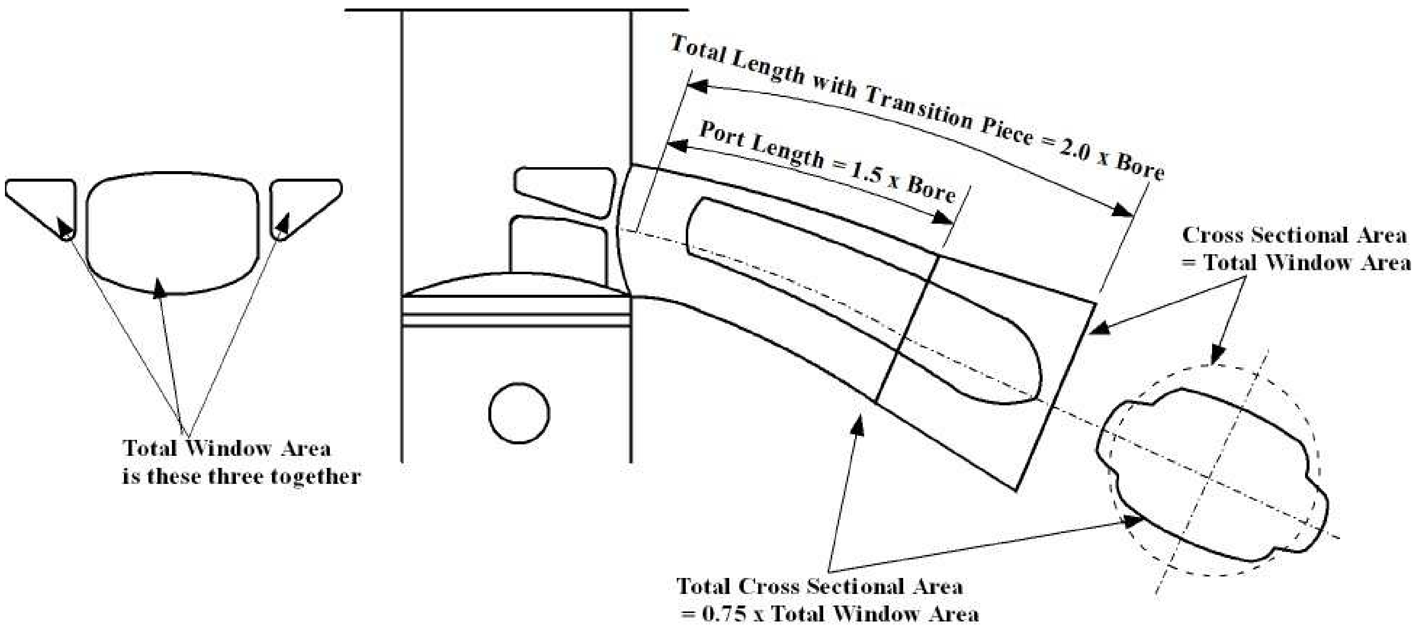
Before designing the exhaust port duct the window is designed to have the required blowdown specific time area required to meet the power requirements of the engine.

## 1. The port/duct areas.

- First we have the effective port area at the bore (that includes the cosine factor of its down angle)
- Then we have the duct exit area = 75% of this effective port area.
- Lastly we have a tapered divergent (CNC) transition spigot that connects the (usually oval) small duct exit, to the round header entrance that is back to 100% of the port effective area we started with.

## 2. The duct/spigot lengths.

- The typical length from the piston face to the end of the duct is approximately 1.5 times the cylinder bore.
- The typical length from the piston face to the end of the spigot is approximately 2 times the cylinder bore.



## 3. Using the results in Post2T to guide the duct design.

We use the Mach number values at different points in the exhaust system:

Once you are into the gas dynamics screen and chose Mach and your project rpm, then the graphical options are:

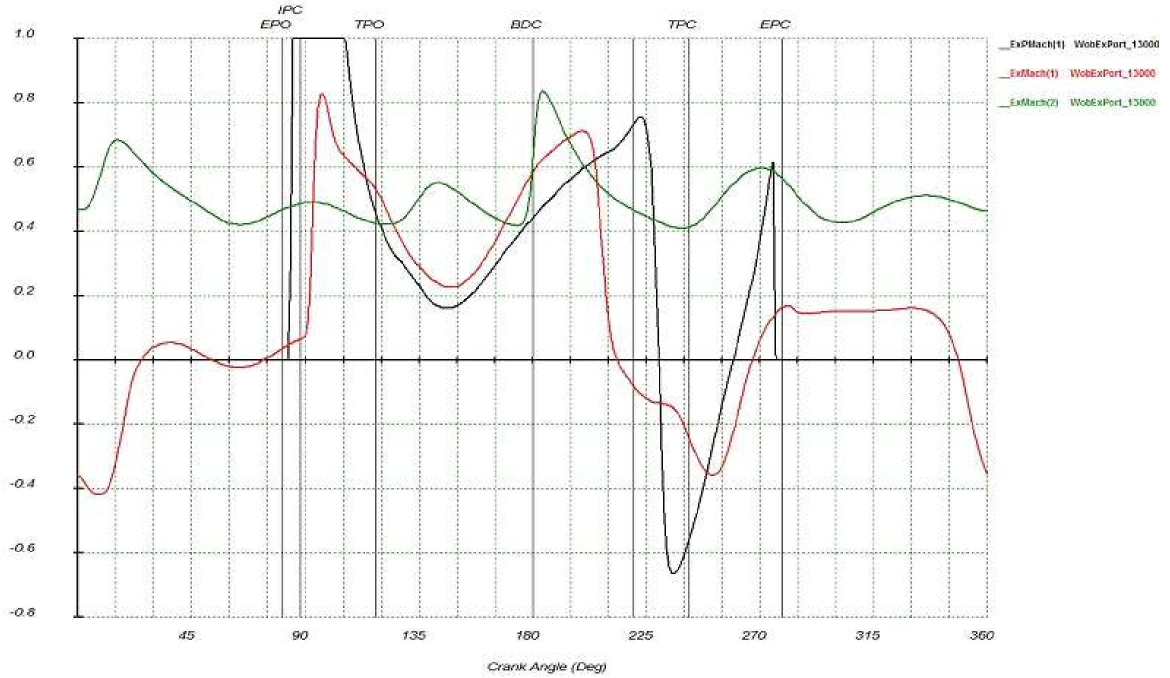
- ExPMach - this is the Mach number at the port face.
- ExMach1 - this is the Mach number at the sensor position you chose in the Engine screen - in this case we want to look at the Mach number usually at the duct exit, where the nozzle area is smallest.
- ExMach2 - this is the Mach number in pipe 2 = the stinger in a normal single cylinder simulation setup.

As the piston starts to open the port we have maximum pressure delta and the smallest area, so the initial flow goes sonic in the ExPMach trace.

Then the Mach number reduces as the area increases and the pressure drops - followed by an increase in flow due to the depression at the port created by the diffuser, this is then followed by the rear cone pressure rise reversing the flow.

At the smallest area of the nozzle (if one is correctly designed) the Mach number will approach 0.8.
I have found that higher or lower affects the power.

Then we have the flow regime in the stinger, and again the best scenario seems to involve a short period of choked sonic flow, followed by a longer period closer to/below Mach 1.




This general guideline gets your port/duct/header setup in the ballpark, and will generally dramatically increase the peak and over rev power. From the start point you can refine the areas and refine the pipe dimensions to enhance this increase or redesign the pipe to improve the mid power with no loss in over rev capability.

## 4. Some guidelines to the duct cooling design.

Ex duct cooling is vitally important to reducing the temp of the retained A/F charge in the Ex duct that is returned to the cylinder due to the rear cone wave activity. This cooling can be increased in many engines by cutting slots or pockets into the spigot mount face such that water is circulating along the full duct length as well as cooling the back face of a bolted on slip joint.

Do not use any ceramic heat barrier materials in an Ex duct, as this will reduce the water cooling effect, but worse, the surface temperature of the duct is increased, exactly what is not needed.

## 5. Spigot design.

The ears that form the ducts extending down from the Aux port tunnels should transition out gradually right thru the spigot, to then finally blend into the round header face shape.

It has also been found to be beneficial to keep the spigot floor shape co-linear with the port floor entry angle, making the full transition angle in the spigot roof only.