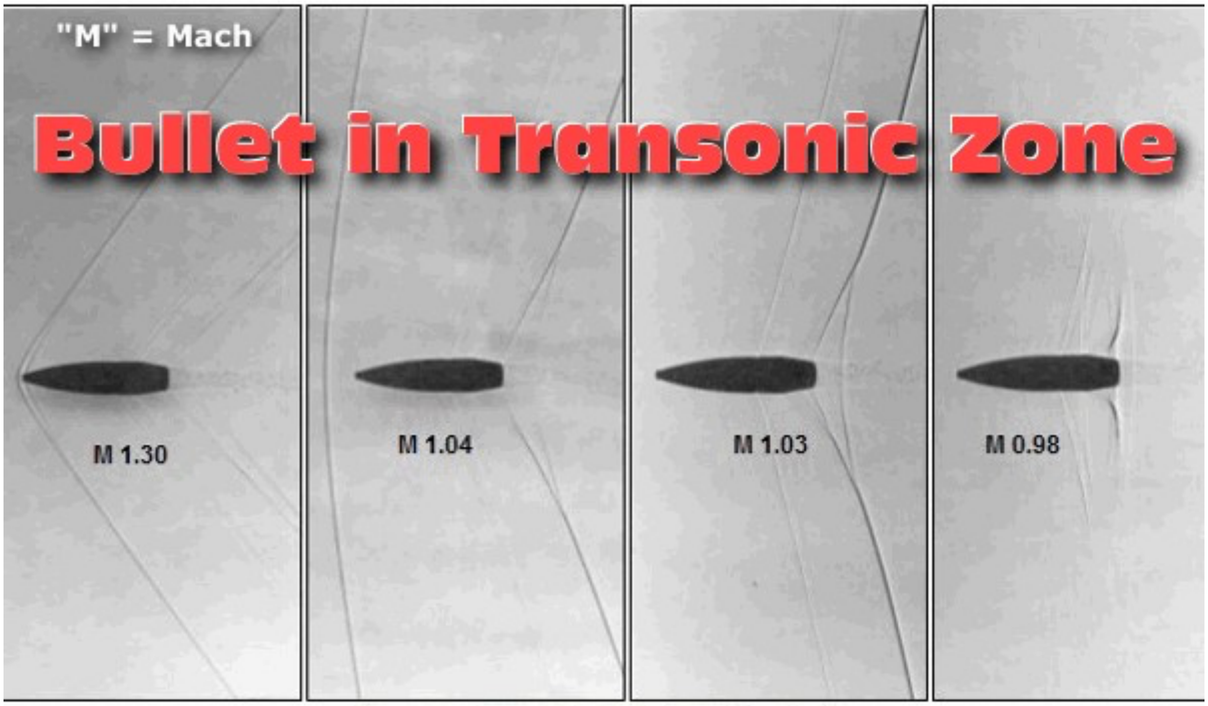
Transonic Effects on Bullet Stability & BC

Bryan Litz explains Bullet Behavior in the Transonic Zone.



These four photos show the substantial changes in the shock wave and turbulence patterns for the same 7.5mm bullet at different velocities. The "M" stands for Mach and the numerical value represents the velocity of the bullet relative to the speed of sound at the time of the shot. Photos by Beat Kneubuehl.

"Going transonic" is generally not a good thing for bullets. The bullet can lose stability as it enters the transonic zone. It can also become less slippery, losing BC as a consequence of dynamic instability. In this video, Bryan Litz of Applied Ballistics analyzes what happens to bullet stability (and BC) as projectiles approach the speed of sound. Transonic effects come into play starting about Mach 1.2, as the bullet drops below 1340 fps.

Transonic Ballistics Effects Explained *by Bryan Litz*
What happens when the bullet slows to transonic speed, i.e. when the bullet slows to about 1340 feet per second? It is getting close to the speed of sound, close to the sound barrier. That is a **bad place to fly** for anything. In particular, for bullets that are spin-stabilized, what the sound barrier does to a bullet (as it flies near Mach 1) is that it has a destabilizing effect. The **center of pressure moves forward**, and the over-turning moment on the bullet gets greater. You must then ask: "Is your bullet going to have enough gyroscopic stability to overcome the increasing dynamic instability that's experienced at transonic speed?"

Some bullets do this better than others. Typically bullets that are shorter and have shallow boat-tail angles will track better through the transonic range. On the contrary, bullets that are longer… can experience a greater range of **pitching and yawing** in the transonic range that will depress their ballistic coefficients at that speed to greater or lesser extents depending on the exact conditions of the day. That makes it very hard to predict your trajectory for bullets like that through that speed range.

When you look at transonic effects on stability, you're looking at reasons to maybe have a super-fast twist rate to stabilize your bullets, because you're actually getting better performance — you're getting less drag and more BC from your bullets if they are spinning with a more rigid axis through the transonic flight range because they'll be experiencing less pitching and yawing in their flight.

To determine how bullets perform in the "transonic zone", Bryan did a lot of testing with multiple barrels and various twist rates, comparing how bullets act at supersonic AND transonic velocities. Bryan looked at the effect of twist rates on the bullets' Ballistic Coefficient (BC). His tests revealed how BC degrades in the transonic zone due to pitching and yawing. Bryan also studied how precision (group size) and muzzle velocity were affected by twist rates. You may be surprised by the results (which showed that precision did not suffer much with faster barrel twist rates). The results of this extensive research are found in Bryan's book Modern Advancements in Long Range Shooting.

Bryan notes: "A lot of gunpowder was burned to get these results and it's all published in layman's terms that are easy to understand". If you're interested in learning more about transonic bullet stability, you may want to pick up a copy of Bryan's book.