

## Advanced Wind Tunnels

1. By the late 1940s, aircraft were expensive to develop and aircraft designers sought to model mathematically and **to simulate an aircraft performance** without building the airplane itself. This, combined with the increasing speed of aircraft, created a great demand for new and **more sophisticated wind tunnels**.
2. Supersonic tunnels operate in a way that seems contrary to logic. As **the throat of a wind tunnel** constricts, one expects the velocity of the air rushing through it to increase. It therefore seems logical that a model should be placed at **the constricted part of a tunnel** in order to take advantage of **the high-velocity airflow**. But as the airspeed approaches Mach 1, the air compresses and also heats up as it **piles up at this constricted part**. Only when the air gets past this constriction does it actually move faster than Mach 1, as the energy stored in both the compression and in the heat the air converts to kinetic energy. Put another way, all of this stored energy has to convert to another form and this form consists of large amounts of air moving very fast through the wind tunnel. This is how a supersonic wind tunnel works, with the model placed in a section of the tunnel where the throat actually expands.
3. By 1948, the National Advisory Committee for Aeronautics (NACA) began operating a 4-foot by 4-foot (1.2-meter by 1.2-meter) supersonic tunnel at Langley, Virginia. Another NACA facility, Ames, located in California, also began operating a slightly larger and more sophisticated supersonic wind tunnel. Because even **the slightest imperfection in the tunnel walls** would **cause the air to pile up and create shock waves**, supersonic tunnels require very **smooth interior surfaces**.
4. Many of the same principles used in supersonic tunnels were also used in hypersonic tunnels to explore speeds greater than Mach 5. But several other problems occur in these types of tunnels. One is that **the power requirements to accelerate the air** are tremendous, so most hypersonic wind tunnels do not operate continuously but **store up tremendous amounts of compressed air** and release it in a brief burst. That is why many hypersonic tunnels have large storage tanks for compressed air. Another issue is: as the air moves out of **the constriction chamber** it cools as its heat energy is converted to kinetic energy. In a hypersonic tunnel, the air can cool so much that it actually liquefies. This is not simply a **case of moisture** in the air condensing. The air itself turns to liquid. The air **is deliberately heated** as it is compressed in a "settling chamber" before being released. In a Mach 10 wind tunnel, for example, the air is heated to 3,000 degrees Fahrenheit (1649 degrees Celsius) so that it does not liquefy when it is released.