

JET AIRPLANE “MACH TUCK”[©]

by Dan Pemble, Kissimmee, Florida –September 3, 2019 (this article was originally titled “Just a Few Aviation-Related Thoughts”)

After writing numerous messages about my own thoughts related to the tragedy of the Lion Air 737 MAX 8 crash and sharing them with current and ex-aviation colleagues, although not at all related to the Lion Air event, it has brought back some of my thoughts about “Mach tuck”. Mach tuck is an inherent characteristic related to many high-speed, swept-wing, jet-powered airplanes; such aerodynamic phenomenon normally occurs at high altitude and high speeds and results in the airplane wanting to assume a nose-down attitude. Thus, for airplanes that exhibit Mach tuck performance characteristics, their design embodies “Mach trim compensation”; this function normally results in the airplane’s elevator and/or horizontal stabilizer to be automatically trimmed a very small amount towards the nose-up direction to preclude Mach tuck; depending on the airplane type, the amount of this trim is very little considering the authority of the relatively-large horizontal stabilizer control surface and/or the authority of the airplane’s elevator at high speed; probably, in most cases, a one-quarter to a one-half degree of nose-up movement for the stabilizer or elevator is sufficient to combat the effects of Mach tuck.

Interestingly, the original design of the McDonnell Douglas DC-10 embodied a Mach trim compensation function known as the Longitudinal Static Stability Augmentation System (LSSAS). However, as a result of flight tests of the DC-10 and the DC-10’s tendency to settle into a few degrees of nose-up attitude during high-speed cruise, the LSSAS function was deemed unnecessary and therefore was eliminated in the design. Actually the DC-10’s nose-up tendency during high-speed cruise is attributed to the wing’s angle-of-incidence relative to the airstream. The wing on the MD-11, a direct derivative of the DC-10, is installed at a reduced angle of incidence such that the MD-11 doesn’t fly nose-up in cruise; as a result, the MD-11 can exhibit Mach tuck; accordingly, a LSAS (Longitudinal Static Augmentation) function is embodied in its design.

You may wonder “where I am coming from” with my recurring “ramblings” about my aviation experiences! Well, as I have stated on many occasions, “Once you get kerosene in your blood, you become addicted and are destined to pursue a career in aviation”. My only problem is the fact that I ended my career in commercial aviation far too soon (in 2009) after only just over 40 years; probably, I would have been good for at least another 10-15 years – if I had not elected to give it all up! I truly do miss the challenges I was confronted with each and every day of my career! And now, all I can do is to re-live some of my experiences and related knowledge and share it with others in writing - hopefully for their interest or possible benefit. I actually got the kerosene in my blood and became addicted to aviation some years ago, as a US Navy Aviation Electrician! It is my hope that many others, especially some of today’s younger folks, will contract this same “ailment” while serving in the military or elsewhere!



The Mighty MD-11