The VNAV problem…and the solution that works for me.

The VNAV system frequently attempts to drive the aircraft towards an overspeed condition. We've all seen it, and we've all heard countless remedies and hypotheses of cause.

My solution to this issue resulted from many hours researching the manufacturer's maintenance, systems, and diagnostic manuals (until access thereof was lost). The result of that loss is that I cannot provide specific references or published examples. So, read further with the healthy skepticism that the lack of official reference demands.

The wind and temperature entries inputted into the FMS effect; optimum and maximum altitudes, ground speed, time and fuel burn estimations, top of climb and descent predictions, Mach number and CAS calculations, etc, etc.

However, my research suggests that no amount of data entry, regardless of accuracy, will prevent the VNAV overspeed problem that we commonly see. So, the question becomes one of, mitigation. But first, why does this overspeed tendency happen in the first place? The answer is surprisingly obvious and simple.

Most jet aircraft transition through the Stratosphere into the Troposphere, and visa-versa, during level flight. However, this is not the case for jets operating in most of Canada's airspace. In Canada most jets cruise in the stratosphere, therefore they climb and descend through the tropopause (with tropopause heights between 16000 to 34000 feet).

> *Remember, the "theoretical Tropopause" of 36050 feet is a scientific value only. Heights are almost always lower in Canada, and higher - much higher - in the Southern USA, all the way to the equator.*

So, how does this affect the VNAV system?

The 'Coles Notes' version is, that the VNAV system calculates a speeds (MACH or/and CAS) to maintain a descent profile. Those profiles are based on angles, referenced to a known axis, normally the earth. So, when wind speed increases or decreases, the slope is adjusted laterally (early/late TOD), or the speed to maintain the slope is adjusted - obviously.

Indicated Airspeed (IAS) is, of course, the issue. Why does it increase towards an over-speed condition when we've made diligent adjustments of windspeed and temperature, etc?   The answer is, that we did not account for the temperature DIRECTION of change.

Recall that, during descent in the Troposphere, a temperature increase of approximately 2 degrees per 1000 feet occurs. With respect to IAS, an increase in temperature results in a decrease in IAS, so as long as the temperature is continually increasing (as it does during descent in the Troposphere) the IAS will continually decrease, but!

When the descent begins in the Stratosphere, where the temperature either does not change with altitude, or, more frequently, DECREASES with altitude, IAS continually INCREASES, until transition through the Tropopause.

So, what's my solution? It's pretty simple.

1. Know where you are in the atmosphere (Troposphere or Stratosphere) and where the transition between those atmospheres will occur.
2. Calculate an IDLE descent point (not the path, just the point).

    ie: Delta Altitude/3.3 + Delta GS/10 = TOD

    Example. FL330. GS 500 knots and Vref (retreated as GS) of 150 knots.

    Altitude change requires 100 miles, plus 35 miles to slow (350 knot change in GS). Total = 135 miles from the elevation reference (in this example, sea level). Note, wind is considered as GS is the reference.

3. Begin an IDLE descent (FLCH Green) at YOUR calculated TOD. Or, use a conservative distance, without doing the math, of about 10 miles before the aircraft's calculated point.

4. Allow the aircraft to descend, without any attempt to maintain a geometric profile until below the tropopause. Once within the troposphere, return to VNAV/PTH and capture the geometric path. With the atmosphere warming as you descend, the overspeed tendency should cease, baring other mitigating factors.

Just my thoughts…