COMBAT FUEL ALLOCATION

Fuel allocation for combat will be calculated based on combinations of two types of "maneuvers," one for energy gain and one for turn performance. Their descriptions are shown below. The descriptions and how they are applied are based on two principles. First, the fuel expended computation of the amount of energy gain and turn achieved will be task oriented, that is, it is assumed that the aircraft with the most power available will be able to accomplish the tasks more quickly. Second, the "maneuver" will be based on the maximum maneuver principle, i.e., the speed chosen for the maneuver will be set to minimize the time needed to perform the maneuver in question (energy rate or turn rate).

Energy Gain (or loss)

The equation for this computation is given by the following extract from page 54 of the draft Military Standard being used for these computations.

$$\text{Combat fuel} = \frac{\Delta E_s \dot{W}_f}{P_s}$$

where E is aircraft energy level, W_f is fuel weight and P_s is energy rate.

This calculation is task oriented, but the conditions for which P_s and the fuel flow, $\dot{W}_f$, are chosen are arbitrary. Two parameters must be specified, altitude and mach number. The altitude should be picked to represent approximately where the energy exchange (altitude change or acceleration) takes place. The mach number, on the other hand, should be chosen based on the flight condition at which the maximum P_s is attained. This principal is in keeping with the principles set out in John Boyd's Maximum Maneuver Concept (reference to be added).

Turn Performance

The equation for this computation is as follows.

$$\text{Combat fuel} = \frac{\Omega \dot{W}_f}{\dot{\theta}}$$

where Ω is the turn angle and $\dot{\theta}$ is the turn rate.

This calculation also is task oriented, but again altitude and mach number must be picked. The same bases will be used for them as before, i.e., the approximate operating altitude

and the mach number at which maximum turn rate is attained. This approach for picking the turn rate also is in keeping with John Boyd's Maximum Maneuver Concept.

The levels set for the energy exchange and turn angle remain arbitrary, as do the numbers of each "maneuver" being used in the combat description. Once they are set, however, the task orientation of the computations will prevent aircraft with higher thrust engines from being penalized in range because it precludes too much fuel being allocated for the maneuvering conditions. Moreover, the maximum maneuver principal assures that each aircraft being compared are allowed to do they best they can at achieving the specific objectives (turn angle or energy change).

Other task oriented descriptive conditions calculated on the maximum maneuver approach are possible. Turns at minimum turn radius (e.g., CAS turns to keep sight of a ground target) and maximum load factor turns (e.g., missile evasion) also can be described.

OFFICE OF THE SECRETARY OF DEFENSE

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MEMO FOR John Boyd

John -

We're going to use these for some range/payload calculations we're making.

Comments?

[redacted]