Potential Modifications to the AIR-1845 propeller thrust equation

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AIR-1845 Propeller Thrust

Why bother with propeller aircraft?

- Air Tours in National Parks (Air Tour Management Plan – ATMP)
- Propeller driven aircraft may be more important in the future
  - Inherently more efficient than jets in some flight regimes

AIR-1845 Propeller Thrust – the equation

What's wrong with propeller aircraft thrust in AIR-1845?

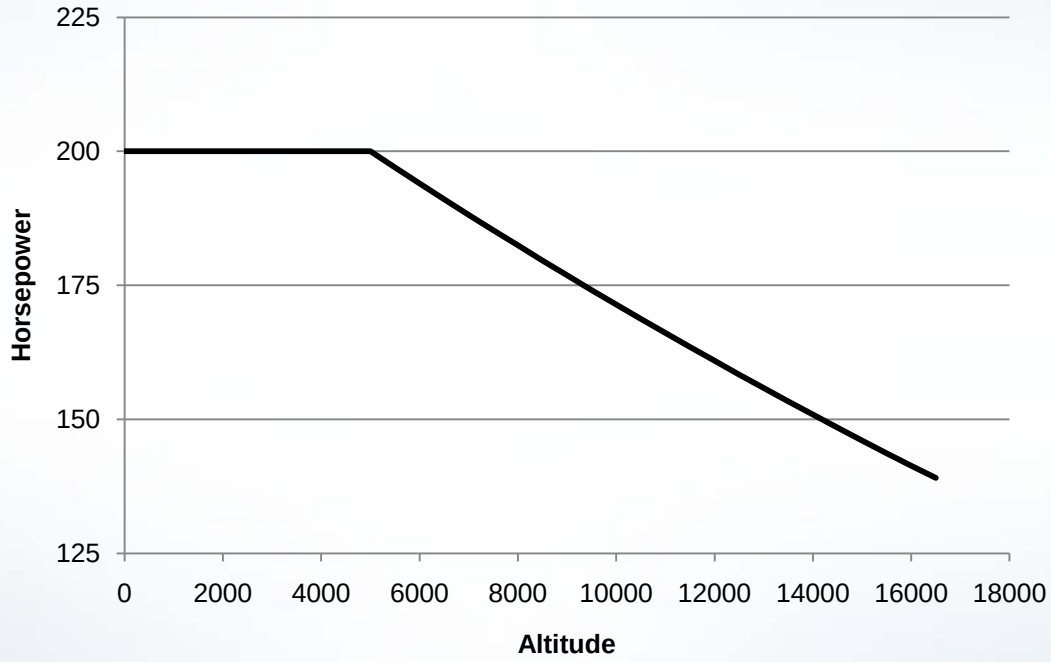
$$\left(F_n / \delta_{am}\right) = \left(\eta P / V_t\right) / \delta_{am}$$

The equation isn't wrong, but it has limitations:

- The velocity term (V_t) in the denominator blows up at low speeds
- The horsepower term (P) is assumed constant
  - We usually treat the term as constant in a particular flight region: take-off or climb
- The propeller efficiency term (η) is assumed constant
  - We usually treat the term as constant in a particular flight region: take-off or climb

AIR-1845 Propeller Thrust – the horsepower term

The Horsepower term can be modified to account for altitude effects



- Nominal 200 HP engine flat rated to 5000 feet, then lapses with density

AIR-1845 Propeller Thrust – the efficiency term

The efficiency term can be rewritten in term of the advance ratio J and the propeller's thrust and power coefficients

$$\eta = J\left(C_T / C_P\right)$$

$$J = V_T / nD$$

$$C_T = F / \rho n^2 D^4$$

$$C_P = P / \rho n^3 D^5$$

AIR-1845 Propeller Thrust – the efficiency term

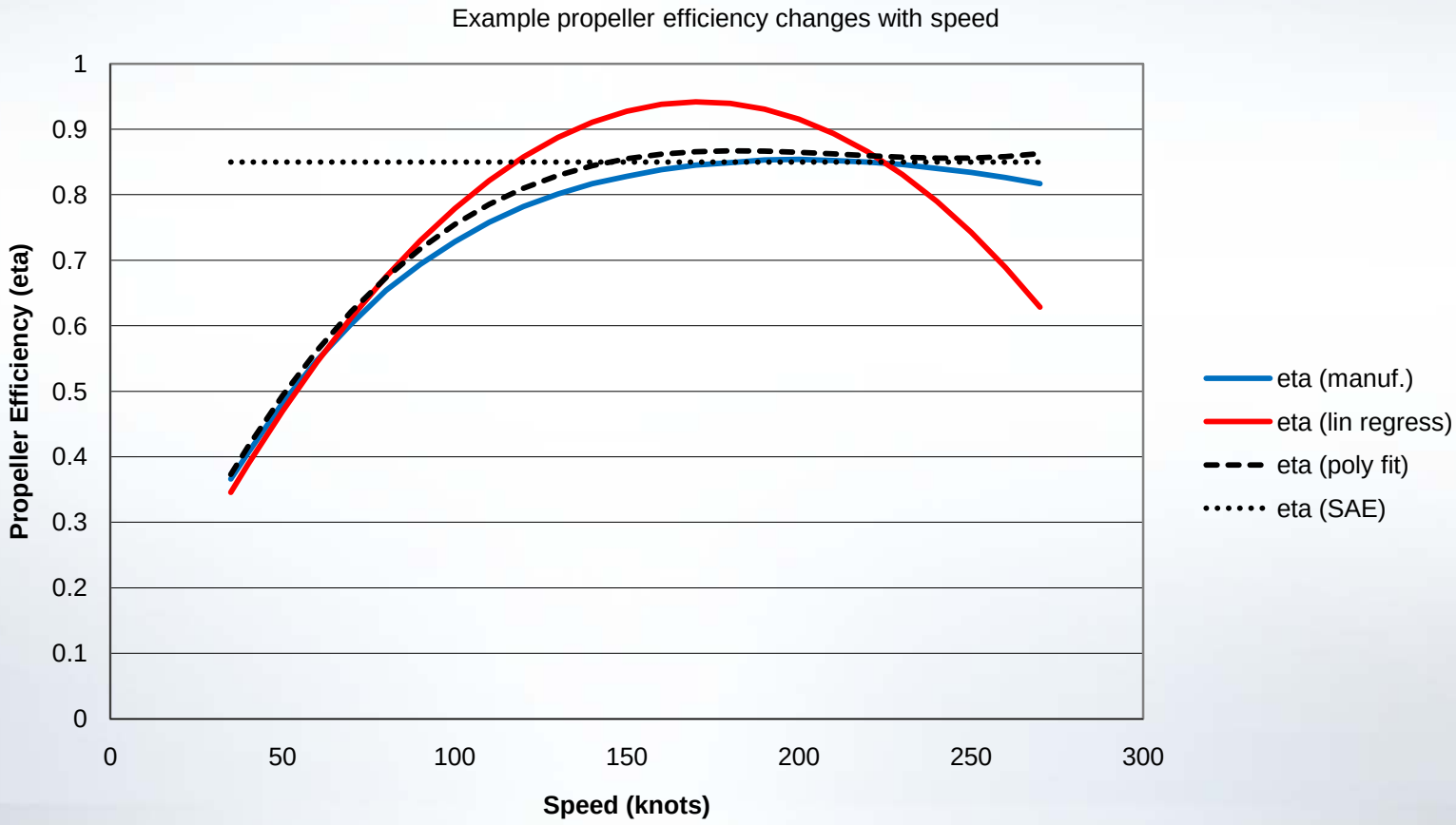
Rather than a constant value of the propeller efficiency, we can use data from the propeller manufacturers to estimate η

- Hartzell and McCauley have both provided detail data on their propellers
  - Spreadsheets from which the user can find the advance ratio, the thrust coefficient and the power coefficient

- We can use the manufacturers' data to estimate the coefficients
  - We can do various types of estimates: linear, polynomial, etc.

AIR-1845 Propeller Thrust – the efficiency term

The efficiency term can be modified to account for speed effects



AIR-1845 Propeller Thrust – summary

The current AIR-1845 propeller equation has limitations

Propeller manufacturers have provided data that may allow better performance modeling – can aircraft manufacturers provide additional information (such as installation effects)?

We have not looked at how these method might allow improved noise modeling of propeller-driven aircraft

We are looking for assistance to help answer these questions…

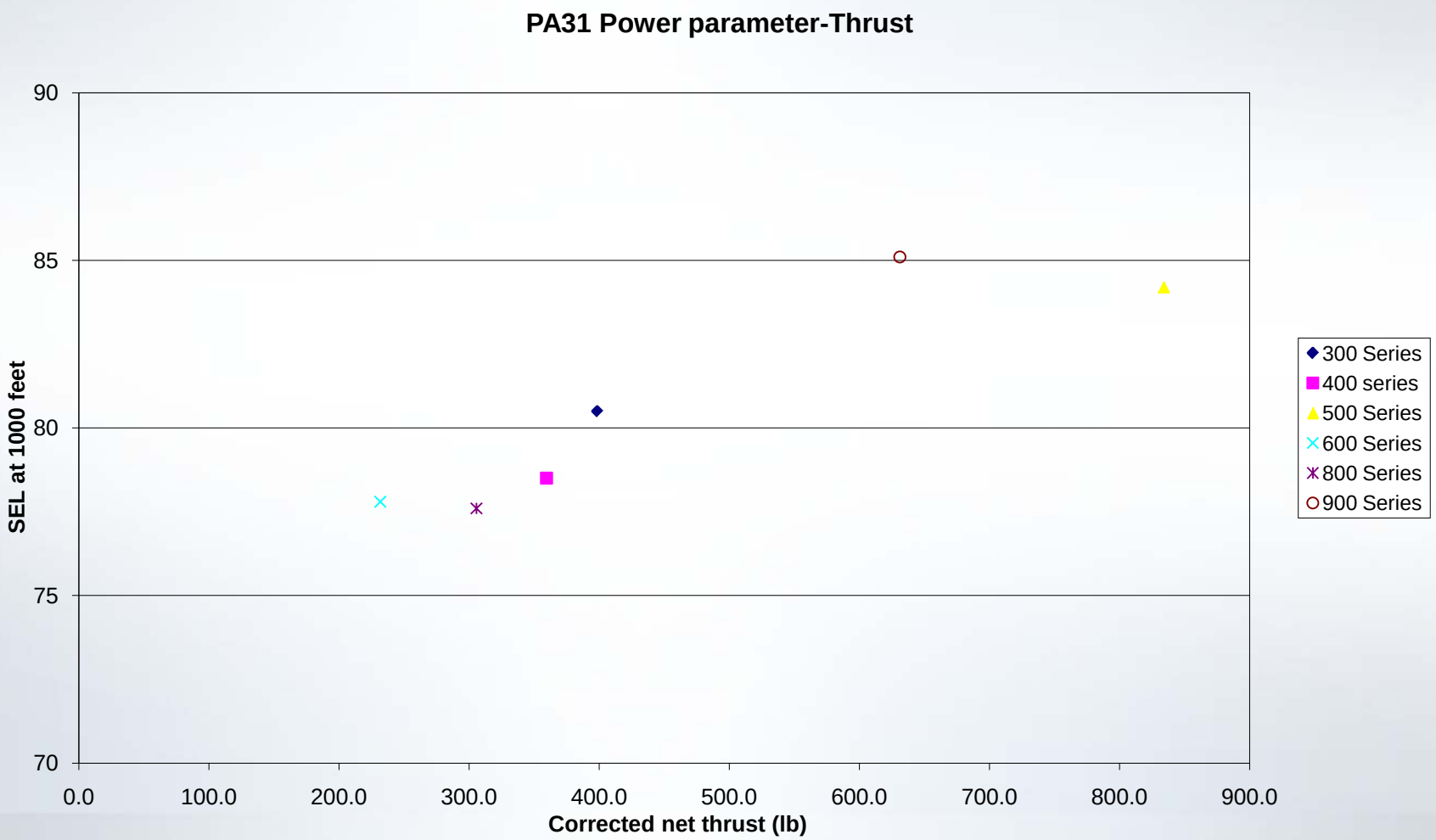
AIR-1845 Propeller Thrust – backup slides

AIR-1845 Propeller Thrust – backup slides

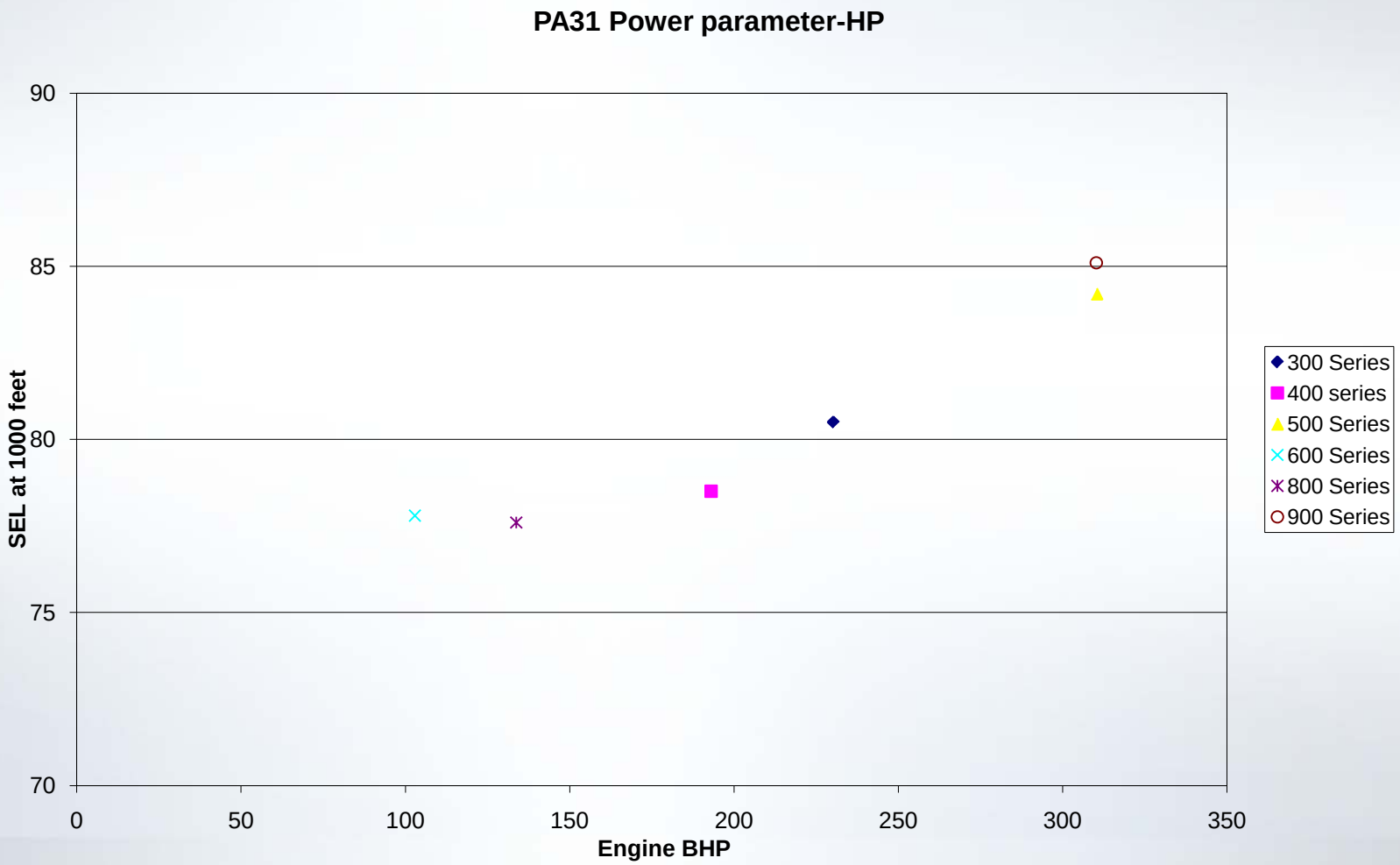
Piper Navajo flight test run series

300 – Level, Medium Power
400 – Level, Low Power
500 – Departure
600 – Arrival
800 – Arrival
900 – Level, High Power

AIR-1845 Propeller Thrust – backup slides



AIR-1845 Propeller Thrust – backup slides



AIR-1845 Propeller Thrust – backup slides