Aircraft Systems Field Exam

ICAO is considering the inverse of Specific Air Range (SAR) as a potential certification metric to assure future air transport aircraft meet minimum standards with regard to greenhouse gas emissions, particularly CO_2.

SAR is defined as the change in range for a given mass of fuel SAR = dR/dW_f and is conceptually equivalent to the miles per gallon metric used for automobiles.

1. From the Breguet Range Equation or first principles derive an expression for SAR which would be appropriate for a commercial aircraft in cruise flight.

2. What vehicle design factors and operational conditions will influence 1/SAR.

3. Discuss how a 1/SAR metric would vary over a typical mission profile of takeoff, climb, cruise, descent, and approach.

4. In order to minimize the certification burden it is desirable to choose a single test condition. What condition would you suggest to be most representative of the aircraft's fuel efficiency performance. Please explain your logic.

5. When designing a transport aircraft, a rational objective for choosing the aspect ratio (AR) is to minimize fuel burn, or equivalently to minimize 1/SAR. So we need to determine the 1/SAR versus AR function to find its minimum. Starting with the result from Q1, or with the Breguet Equation, explain what factors are significantly influenced by AR. Explain what techniques or disciplines are needed to actually determine these dependencies quantitatively.

6. What practical considerations might push an airplane maker away from the theoretical optimum AR defined in 5?