ENAE 483/788D LECTURE #06 (RELIABILITY) PROBLEMS – FALL, 2024

(1) Falcon 9 flew successfully 18 times prior to its first failure. What was its reliability prior to the failure at an 80% confidence?

(2) What was its reliability after the failure at the same confidence level?

(3) Falcon 9 had a second in-flight failure on mission 354. If you assert that its reliability is 99%, what is the confidence in this estimate prior to the failure?

(4) What is the confidence in this estimate after the failure?

(5) Falcon 9 Block 5 first-stage boosters have landed successfully 326 times on 331 attempts. At an 80% confidence level, what is the reliability of first stage landing?

(6) There are 33 Raptor rocket engines on the first stage of the Starship first stage. If each engine is 99% reliable, what is the probability of no failures during a launch?

(7) If Starship can survive two Raptor failures during the first stage burn, what is the probability of a successful first stage launch?

(8) How does your answer to the previous question change if there is a 20% intercorrelation rate in Raptor failures?

(9) In this phase of the program, Starship should nominally fly every 4 weeks. Due to regulatory issues, it is down for 16 weeks following a failure. In a surge condition, it can fly every 3 weeks. To be resilient with no loss of payloads in the manifest, what is the minimum number of successful launches expected on average between failures?

(10) Sending a Starship to Mars and landing will require onboard systems to operate continuously for 300 days. For a single unit, what would the required mean time between failure (MTBF) be, in hours, for a 99% reliability on the mission to Mars?

(11) There are 10 LED lighting units in the Starship habitat for the trip to Mars, each of which is 99% reliable over that mission duration. How many spares should they carry to have a 99% chance of having 10 functional units when you arrive at Mars?