SHOCKS & STARS ENGINEERING

AEROFLUX II: Aerothermal Analysis of Dorsal Mounted Avionics System LRU in Unconditioned Bay

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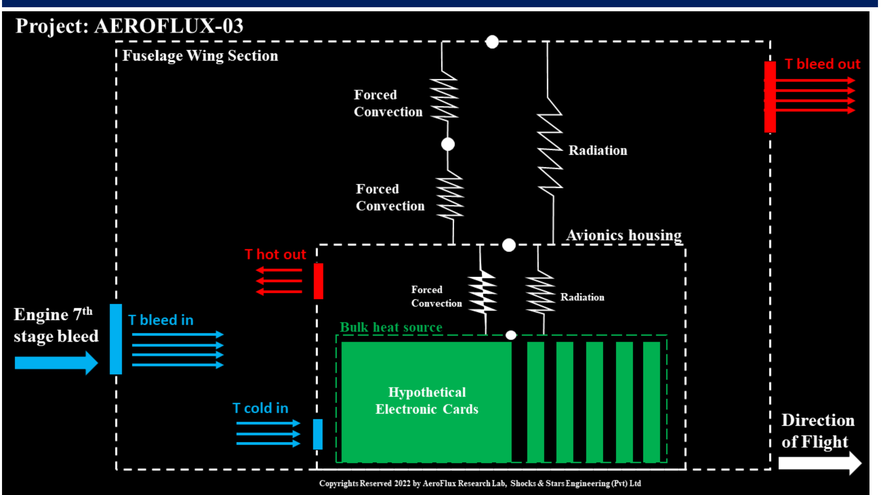
Problem Statement

The **aerothermal analysis** of the avionics system LRU placed inside an **unconditioned bay** of the dorsal area. In an unconditioned bay, the **ambient parameters** are dependent on the **atmospheric parameters**. Whereas the atmospheric parameters are changing continuously due to the **drastic change** in the **altitude** of the airborne platform. Hence, a **novel math algorithm** is required to solve the **aerothermal conjugate heat transfer parameters** at varying altitudes and ambient conditions.

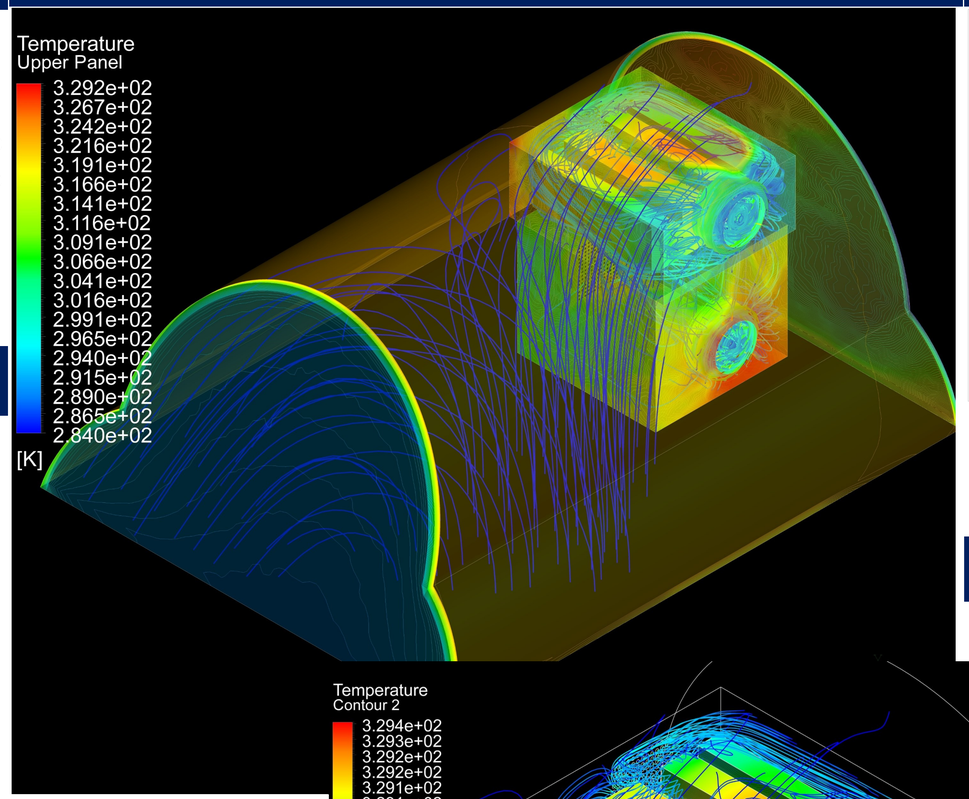
Methodology

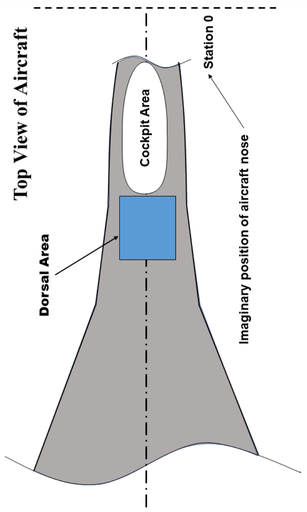
Math Model	Analytical Analysis	Computational Analysis	Design of Experiment (DoE)	Solution of Flight Regime
Conjugate heat transfer and combined convection and radiative model	Closed-form solution of the math model and comparative analysis of operating and thermal parameters	CFD analysis for the verification of the analytical solution at different altitude	Computation-al DoE using Ansys Design Explorer for the solution of the whole flight envelope at 80 design points	Surface and enclosure wall temperature graphs. Effect of operating parameters on the surface temperature. Qualification under MIL E 5400

Case Scenario

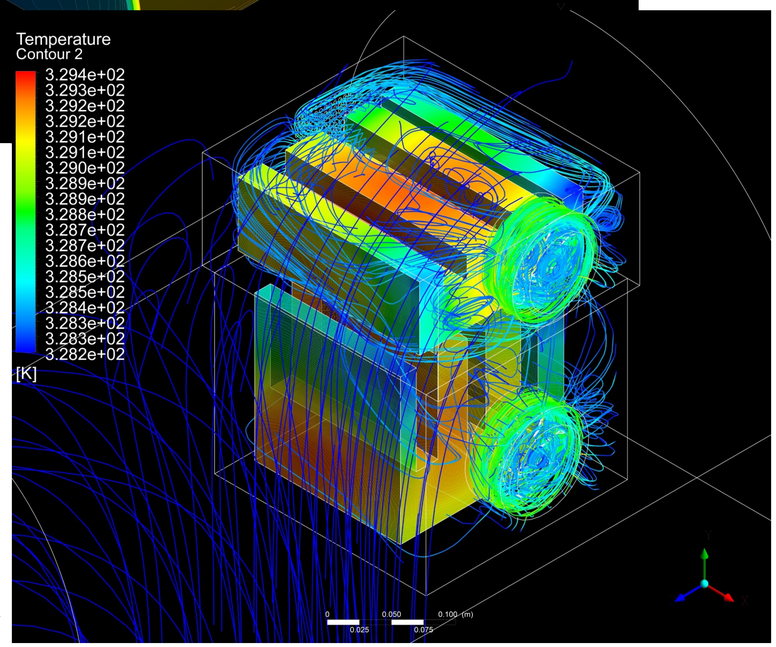


Simulation Results



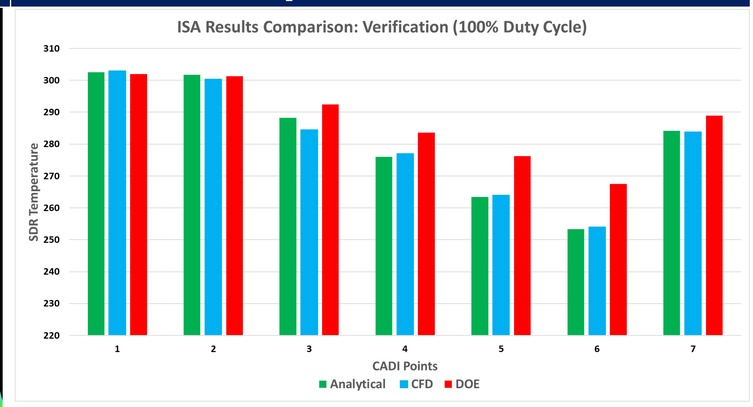


Location of Dorsal Area on aircraft



Close-up view of SDR housing placed inside the dorsal bay area

Comparison Plots



These plots show a **high degree of conformance** i.e., an error margin of **less than 3%** is noted between the **computational** and **analytical** methods.

Conclusion

- The **Math model** successfully produced analytical temperature under the unconditioned bay environment with free and forced convection **repeatedly**
- For altitudes **above 40kft**, there is a considerable **reduction in heat transfer** coefficient, which is combined with the thermos-pause (**constant thermos-pause temperature**) conditions resulting in a **temperature build-back** on enclosure walls as well as SDR surface
- **Computational** results of FVM as well as FEM are **verified** by the closed-form analytical aerothermal solution
- **Solutions** of **three different methods** i.e., **analytical, computational** FVM and FEM, and **DoE** are **validated** by the **experimental and test/trial data**