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A Figure of Merit-Based Computational Heat Transfer Method for Aerothermal Analysis of Airborne Electronics System LRU

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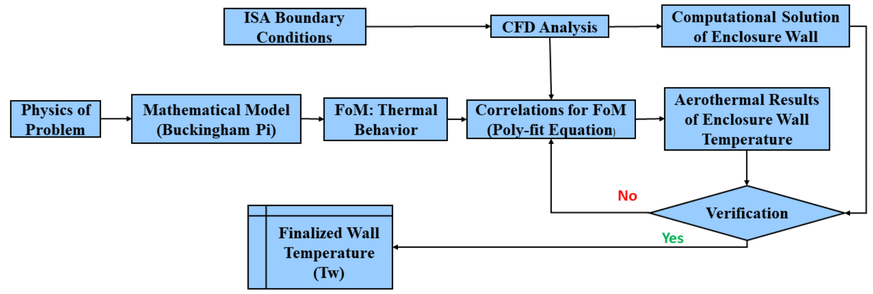
Research funding # CO2SDM5N-OOSAT-OTSO2638-21084 (SPRC Govt. of Pakistan)

Problem Statement

The **aerothermal analysis** of airborne electronics is a **complex** and **computationally intensive** process, especially during the **conceptual design phase**. This research, therefore, introduces a **Figure of Merit (FoM) based approach** for **high fidelity** initial assessment of aerothermal parameters of electronics system LRUs installed on **airborne platforms** placed inside the **dorsal area** of **unconditioned bays.**

Methodology



Math Model

FoM 1:

$$\pi'_1 = \frac{q''}{T_w . h_c} \times 400$$

FoM 2:

$$\pi'_2 = \frac{q''}{\rho v^3} \times 40000$$

Arbitrary Weights

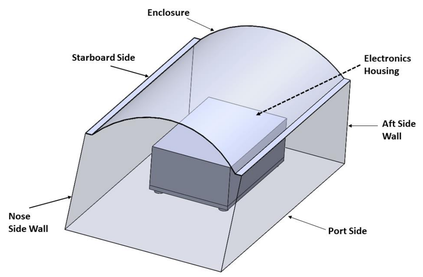
Poly-fit Eq:

$$\pi'_1 = a_1 . {\pi'_2}^3 + b_1 . {\pi'_2}^2 + c_1 . \pi_2 + d_1$$

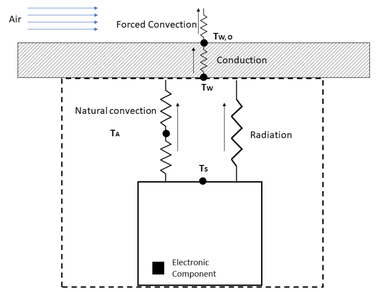
Constant Terms	Values
a	9×10^{-4}
b	-5.1×10^{-2}
c	1.8518
d	-0.3771

Case Scenario

The schematic diagrams depicts the **electrical analogy** of LRU model for the heat transfer.

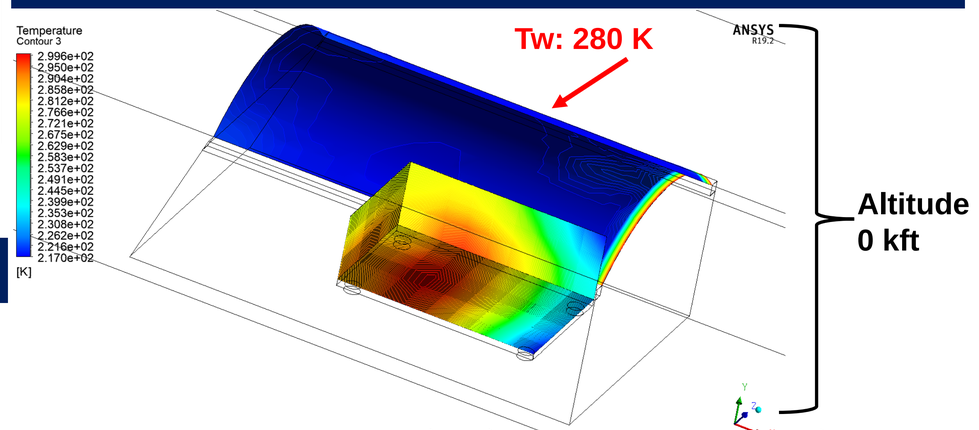


Problem Scenario

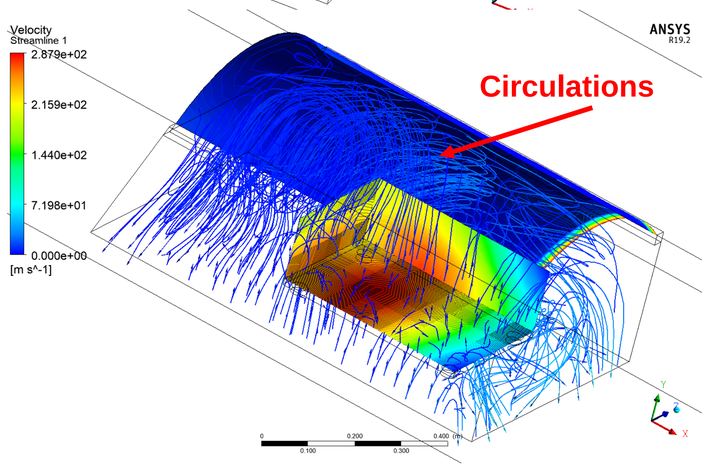


Electrical Analogy

Simulation



Altitude 0 kft

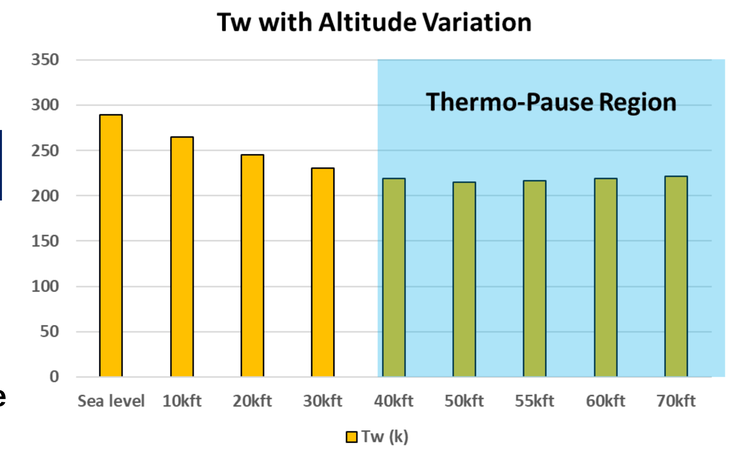


Altitude 0 kft

Figure of Merits for 0 kft:

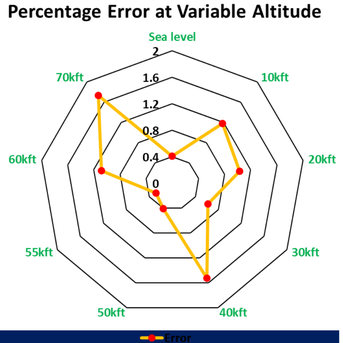
Altitude	ρ (kg/m³)	h_c (W/m².k)	q" (W/m²)	V (m/s)
Sea level	1.225	610.8	987.9	280
40kft	0.3015	199.0	987.9	280

Results



Percentage Error at Variable Altitude

Altitude	Tw – Analytical	Tw- CFD	% Error
Sea level	289.18 K	288 K	0.409
10kft	264.82 K	268 K	1.1837
20kft	245.43 K	248 K	1.0333
30kft	230.42 K	229 K	0.6171
40kft	217.00 K	216 K	1.5215
50kft	215.12 K	217 K	0.405
55kft	216.37 K	217 K	0.2858
60kft	219.38 K	217 K	1.087
70kft	221.84 K	219 K	1.7353



Conclusion

- **The FoM solution** is in **good conformance** with **computational** results
- The **FoM method** solve the **high fidelity** and **frugal solution** for the assessment of **thermal parameters** of avionics system LRU