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Crisis in Power Engineering Education – A National Security Concern & Lockheed Martin Perspectives

Education Workshop

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Lockheed Martin Overview

- Electrical Power is integral to (and critical to proper functioning of) MANY IF NOT ALL Lockheed Martin prime platforms, and the needs are becoming increasingly complex
  - Missiles, Spacecraft, Aircraft
  - Platforms are High Priorities for our Nation's Defense
  - More and more systems are requiring electricity
    - Efficiency, weight and volume optimization
    - Ability to manage and tolerate heat is a rising concern
    - Ability to Generate and deliver the required amount of power and of reliable quality *in the limited space and weight* is another rising concern & challenge

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Lockheed Martin Aircraft & Electrical Power

- There are different power source types and types of power used throughout Lockheed Martin
  - Power is Generated, Converted, Distributed and Stored
  - Motors, Generators, Batteries
    - Power ranges from 10’s to 100’s of kilo-Watts, several Ahrs
    - Very high rpm sources to Generators (Engine turbines)
  - Alternating Current (AC) and Direct Current (DC) forms
    - 115Vac/400 Hz, 28Vdc and 270Vdc are most common for prime
  - Bi-directional power flow (source to load and vice versa) becoming common (leverage, but manage it safely)

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Skills Required in Power

- Within the overall Lockheed Martin Electrical Power Discipline, a variety of specific skills (with related coursework), interest areas and types of personalities are needed
  - Magnetics, Physics, Maxwell's Equations, etc. (Generators, Motors)
  - Power electronics (Distribution Systems, Power Conversion)
  - Electrochemistry (Batteries, Stored Energy)
  - Materials (Components, Harsh Environments, etc.)
  - Controllers, firmware & software (EPS modern designs involve firmware and software spanning hardware to systems level, & serial comms like ethernet, I2C, 1553)
  - Work Independently, or in teams (often if not always work involves teams), work with suppliers (manage the design in some cases)
  - Comfortable in a lab setting, and/or office and design/analysis

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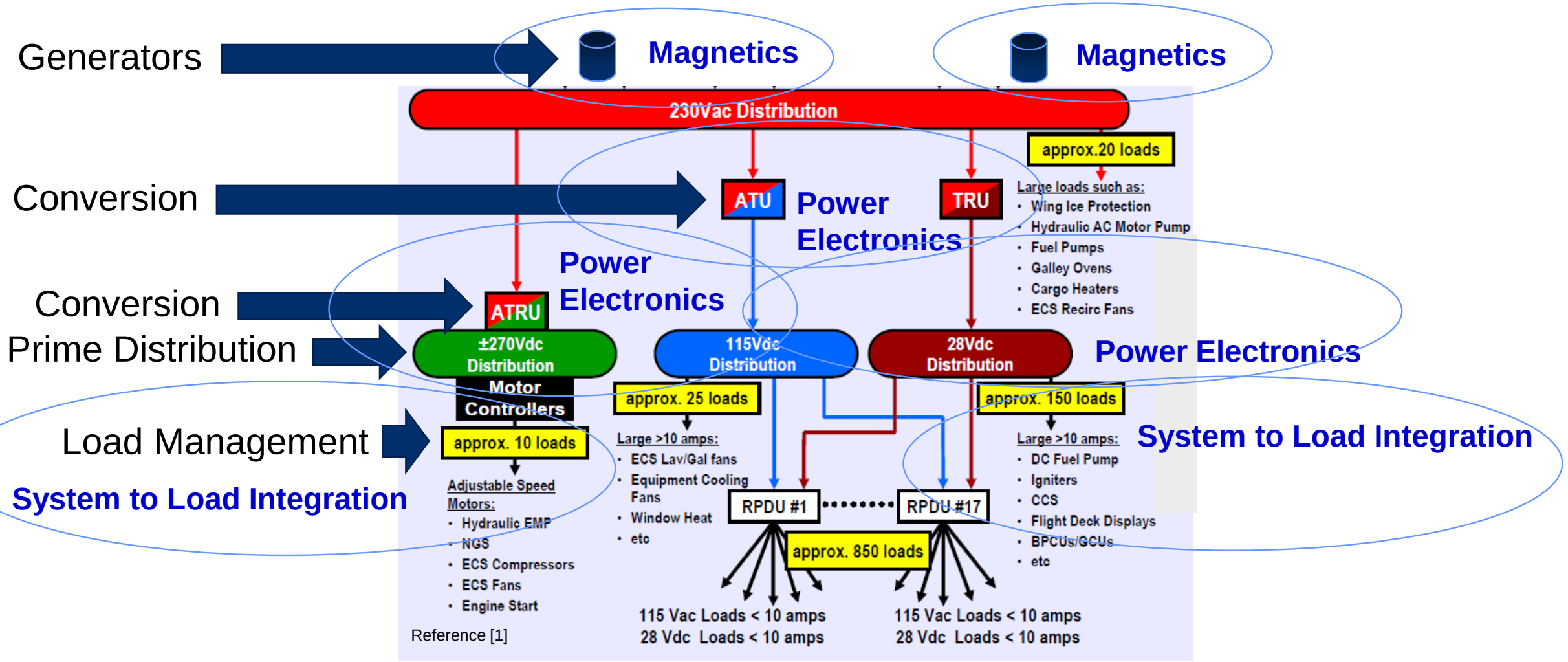
An Aircraft (Commercial Platform) EPS



Reference [1]

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Skills Required in Power – Modeling & Simulation

- The dynamics of a modern Aircraft Power System are complex, and often difficult to anticipate outcomes in performance purely through analyses
- If we wait until systems are installed on an Aircraft to learn about failure modes or other peculiarities in operation it is too late, and very costly to the program (& the customer) to implement fixes
- So…. modeling and simulation to fully characterize power equipment when wired together can be a key risk reduction
  - This has become even more critical with newer more complex power equipment & integrated Avionics, high power and very high energy dense power supplies and batteries (lithium-ion, etc.)

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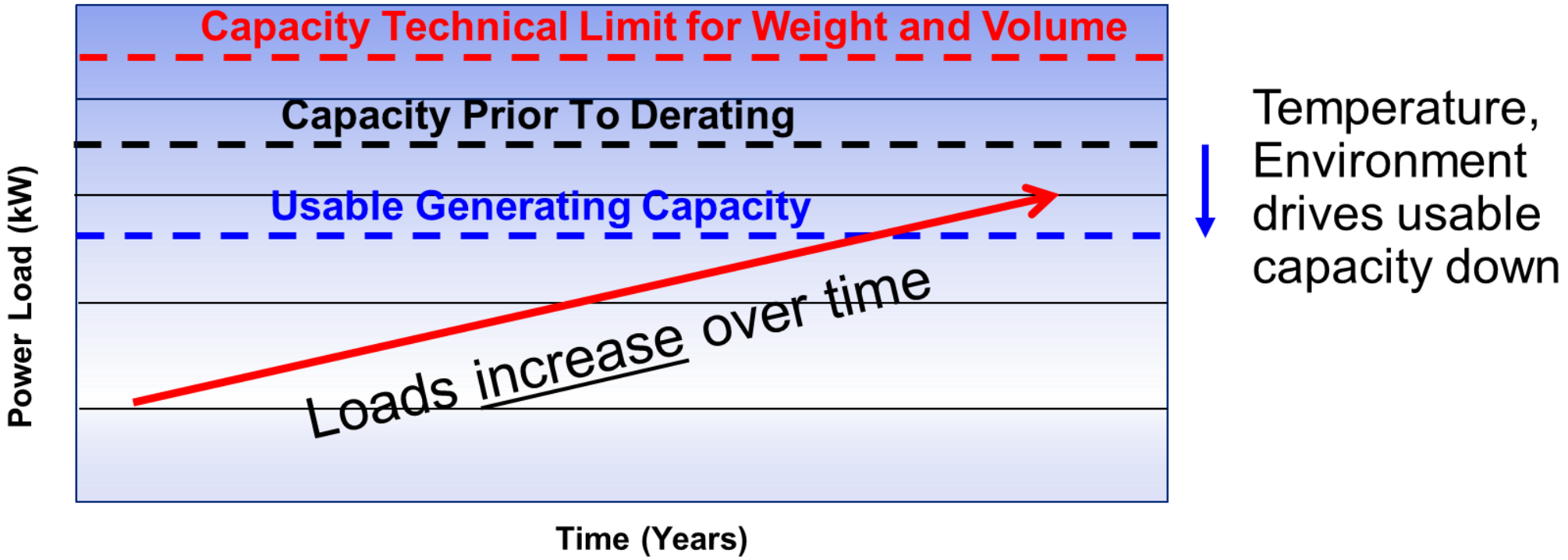
Temperature Impacts drive a need for Harsh Environment Capable Electronics



Increased power loads and temperatures drive to self-defeating demand for more cooling system power

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Critical Areas for Lockheed Martin as a Prime Contractor

- Either we design the power supplies and certain other hardware in-house (distribution units, bus assemblies, etc.) with the expertise to produce reliable flightworthy hardware, OR…
  - We outsource to suppliers
    - Highly skilled populations of EE's need to ask the right questions, early in Design Review phases & know what to look for to guarantee low risk design when integrated onto the platform for our customers
  - Many pieces of hardware are procured from sub-tiers and likely will be into the future including:
    - Generators, Power Carts, Facility Power
    - Battery Subsystems
    - DC to DC and DC to AC Converters
    - Relays, Solid State Switches

Norm Augustine quote:

"We can't hope to manage our suppliers unless we are smarter than them."

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Opportunities & Challenges

- Opportunities are challenging & growing rapidly for a career in Electrical Power
- Lockheed Martin has experienced large turnover (& retirements) in recent years
  - Electrical Engineers are a particular shortage area, though other disciplines have seen large attrition as well (Mechanical, etc.)
  - Need to be a US Citizen
  - As a Corporation, we are working to leverage skill mix across all Lockheed Martin Business Areas
    - Creating a more virtual workforce, including within the Engineering population
- A key in acquiring and retention of the younger workforce is creation of exciting, early career work with agile paths to positions such as Technical Fellowship and higher compensation. Meaningful work early on seems vital!
- Alternatives to certain materials and metals are being investigated by Lockheed Martin due to strategic sourcing considerations
- COVID has been a driver in supply chain delivery delays as well as Trusted and Secure Sourcing of microelectronics

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References

[1] Graphic from presentation by Tim Nelson of the Boeing Company at 2012 SAE Power Conference in Mesa AZ

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Questions?

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