Electrical Power Generation and Distribution in Boeing-777

Bryan Faulkner

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Power Generation - 777

The Boeing 777 electrical system is "comprised of two independent electrical systems" the main and the backup [1]. The main system involves "two engine-driven integrated drive generators, a generator driven by the auxiliary power unit (APU), three generator control units, and a bus power control unit [1]."

In order to provide for redundant contingencies, in case of failure, a backup electrical system is included with every aircraft. Included in the backup design are "two-engine driven generators and one inverter/control unit [1]". When all of the systems/redundancy plans are considered, as a whole, they are equivalent to a three-engine plane (the 777 only has two physical engines); essentially, the 777 has a backup engine.

The specifications of the power generation of the 777 are as follows [1]:

- 3 Phase
- 115 VAC
- Line-to-Neutral
- Constant Speed
- 400 Hz

Power Distribution – 777

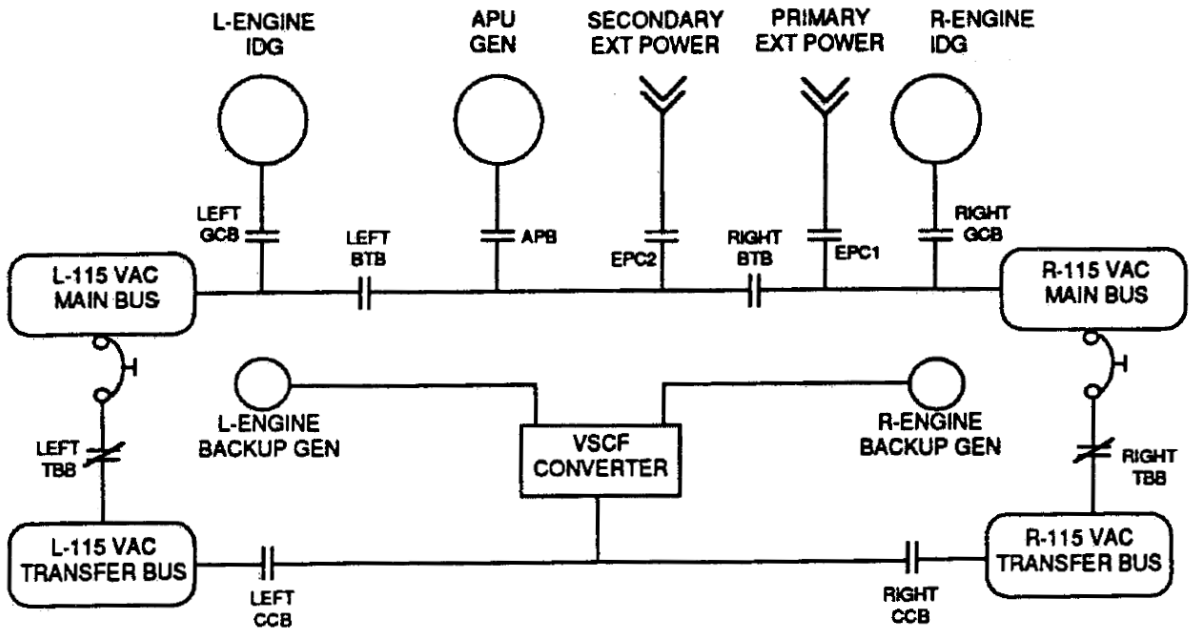

Figure 1. Main AC Electric Power and Backup Power Schematic

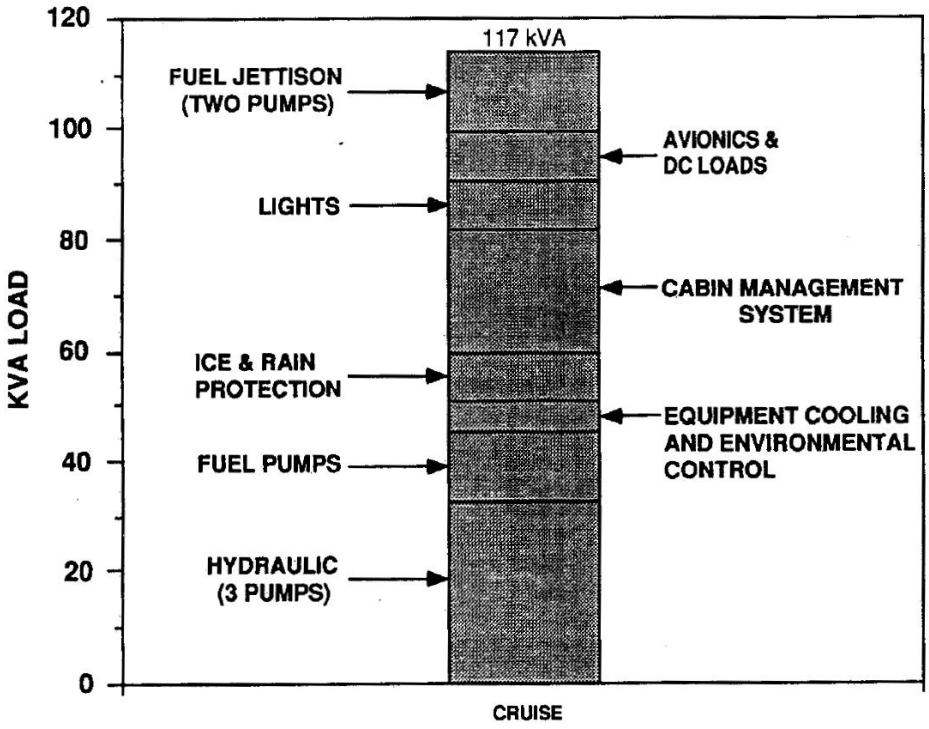

Figure 2. Single Main Generator – Flight Operation – Electric Load Breakdown

Power Distribution – 777 (Continued)

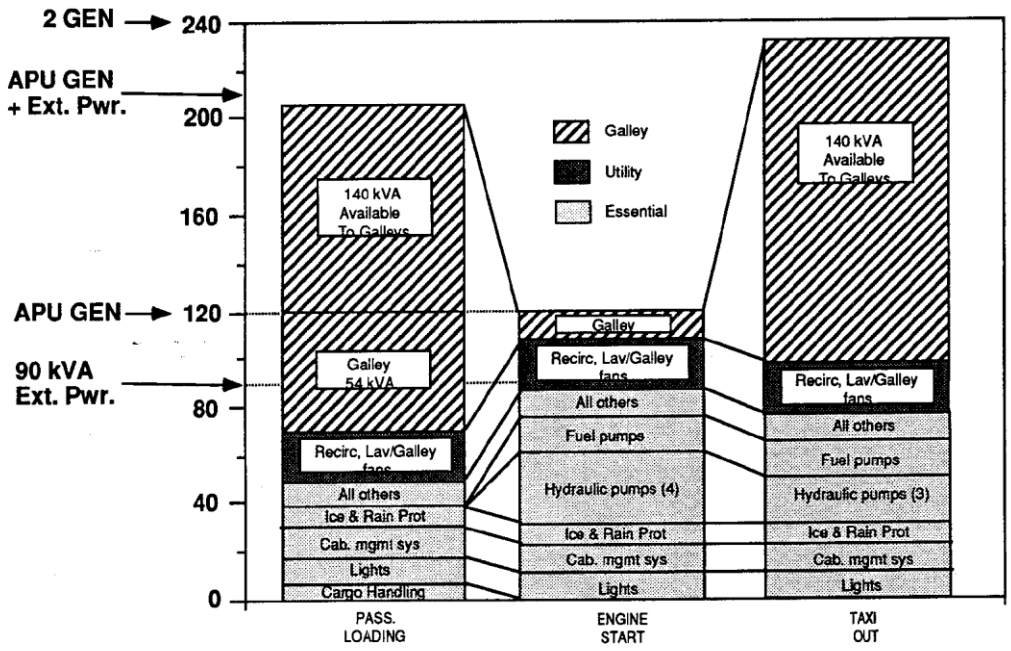

Figure 3. Various States of 777 Operation - Electric Load Breakdown

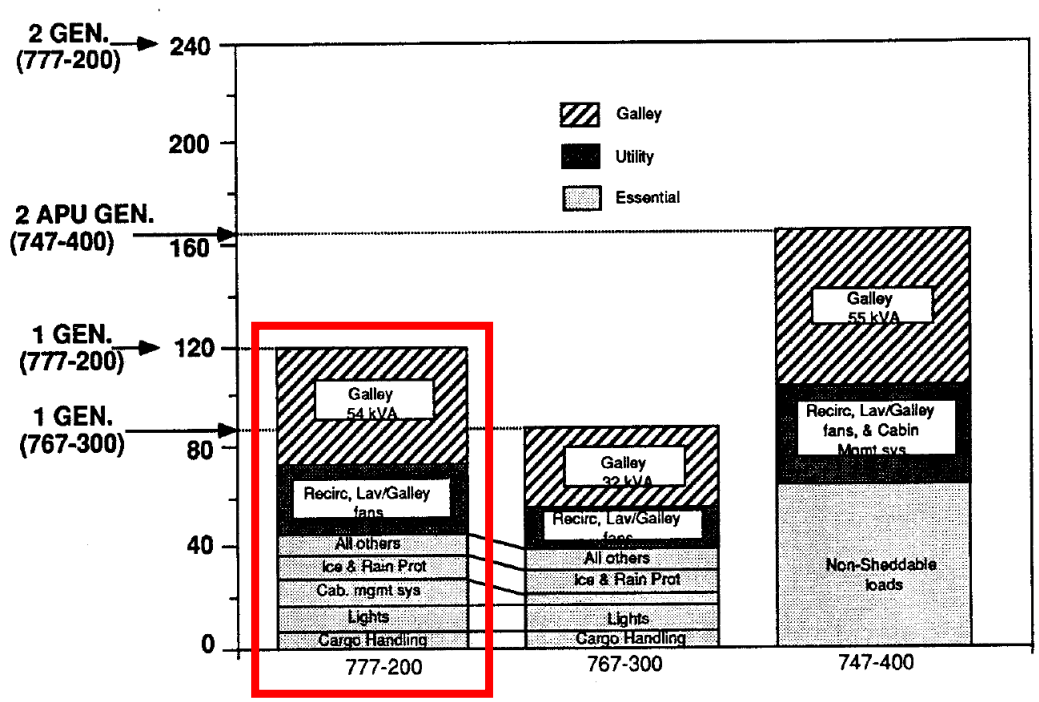

Figure 4. Passenger Boarding - Electric Load Breakdown & Comparison

In the first figure (Figure 1), the overall 777 Main AC Electric Power and Backup AC Power schematic, is illustrated. At the top of the diagram, the 5 sources of energy can be seen; the Left and right Engine Integrated Drive Generators (IDG), the Auxiliary Power Unit (APU) Generator, and the Primary and Secondary External Power Sources. Throughout the remainder of the schematic, several different types of breakers are employed; i.e. Left and Right Generator Circuit Breakers (GCB), Left and Right Bus Tie Breakers (BTB), and an Auxiliary Power Breaker (APB), Left and Right Transfer Bus Breakers (TBB) halfway down the schematic, and Left and Right Converter Circuit Breakers (CCB) at the bottom of the schematic. Towards the top of the schematic, External Power Connectors (EPC) 1 & 2 connect the External Power Sources to the busses. Tying all the components together, are the Left 115 VAC Main Bus and the Right 115 VAC Main bus, as well as the Left and Right Transfer Busses [1].

The components, which were previously mentioned directly above (as part of Figure 1), are also networked to Left and Right Engine Backup Generators, as a contingency if other generators fail during system operation. The backup generators are connected to the rest of the schematic network by a single Variable Speed Constant Frequency (VSCF) Converter [1].

In the previous three figures (Figures 2-4), breakdowns of the various electric loads, at different modes of operation are illustrated. In Figure 2, for the 777, the Single Main Generator, Electric Load Breakdown is as follows, totaling 117 kVA during flight operation (in order of greatest amount of apparent power consumed, to the least – values are approximate):

1) Hydraulic (3 Pumps) ~ 30 kVA
2) Cabin Management System ~ 20 kVA
3) Fuel Jettison (Two Pumps) ~ 17 kVA
4) Fuel Pumps ~ 15 kVA
5) Similar Apparent Power Levels:
    a. Ice & Rain Protection ~ 10 kVA
    b. Avionics & DC Loads ~ 10 kVA
    c. Lights ~ 10 kVA
6) Equipment Cooling & Environmental Control ~ 5 kVA

In Figure 3, various states of 777 operation, and the associated electric loads, are broken down/segmented in the illustration. Figure 3 compares the electric loads required during passenger loading (left), engine start (middle), and aircraft taxiing (right).

In Figure 4, various Boeing aircraft, and their electric load requirements, are provided. The electric loads are being compared during passenger boarding. The information inside the red box is pertinent to the 777.

Work Cited

Andrade, L.; Tenning, C., "Design of the Boeing 777 electric system," *Aerospace and Electronics Conference, 1992. NAECON 1992., Proceedings of the IEEE 1992 National* , vol., no., pp.1281,1290 vol.3, 18-22 May 1992
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