TECH TIME

Helpful tips for the Avionics Technician

BY AL INGLE

This month we continue our study of electrical load analysis, a subset of *wiring systems*. As was explained previously, an electrical load determination is required when installing new equipment into an aircraft or when questions arise as to the state of an electrical system. The British Civil Aviation Authority has already addressed many, if not all of these deficiencies through an *Airworthiness Information Leaflet* titled *AIL/0194, Issue 1, 25 March 2004*. This is a well written and thorough document and will be used as a guide in this series. It may be found at www.caa.co.uk.

Having given definitions and assumptions to related terms and parameters in earlier articles, it is now time to create the outline of an Electrical Load Analysis (ELA) for review. It should be understood that the ELA could be a simple calculation (or measurement) or a complex one. An analysis performed by a repair station may be fairly simple for an avionics installation in which the basic load configuration changes little, if any. At the other extreme would be the analysis performed during the design and certification of a new aircraft. Somewhere in the middle is where we are going to go with our ELA template. It begins with an Introduction:

Load and Power Source Capacity Analysis

A. Aircraft Make, Model, Serial Number, Registration Number, Aircraft Total Time
B. A brief description of the system operation including primary and secondary power sources should follow.
C. A wiring diagram or electrical schematic may optionally be included, along with battery discharge curves.
D. A description of the load shedding logic i.e.: is the load shedding automatic or is the pilot informed of the electrical malfunction by annunciation (or other means) with systems manually taken off-line?
E. A list of installed equipment. How comprehensive this list must be is open to debate. However, in the case of a repair station performing an installation, the list should at a minimum include all avionics components that were powered during the test.

Below is a sample table for power sources typically found in larger aircraft.

IDENTIFICATION	1	2	3
ITEM	**DC Starter-Generator**	**Inverter**	**Battery**
No. of Units	2	1	1
Continuous Rating (Nameplate) 5 seconds Rating 2 minute Rating	250A 400A 300A	300VA (Total)	35Ah
Voltage	30V	115VAC	24VDC
Frequency	-	400Hz	-
Power Factor	-	0.8	-
Manufacturer	ABC	XYZ	ABC
Model No.	123	456	789
Voltage Reg	±0.6v	±2%	-
Frequency Regulation	-	400Hz ±1%	-

AC and DC Load Analysis – Tabulation of Values

Components in systems may be listed separately, or with the systems lumped together, depending upon the detail required of the analysis. In many aircraft the "quiescent" current being drawn with the Master switch turned on may constitute the lowest and most fundamental electrical load and be recorded as such. For an ELA performed prior to the installation of new equipment, the existing circuit breakers could be listed in associated groups i.e.: Aircraft Master engage (quiescent operation), Lighting, Avionics, Flaps/Gear, etc. The loads could also be grouped according to ATA codes. The actual consumption of current could be determined by applying a "clamp-on" type of ammeter to the battery or main current carrying conductor for that test. The circuit breaker values are not a good indication of actual current consumed as they have a safety margin built in and are primarily there to protect the wiring. Below is an example of the table constructed to record the values measured.

Circuit/Service	Circuit Breaker	Load at CB	Operating Time	Conditions	Notes
Aircraft Master	**Name**	**Amps**	**Minutes**		
Master Relay	Master	0.8	Continuous		
Generator Control 1	GC1	1.2	Continuous		
Engine N1 Gauge	#1 N1	0.4	Continuous		
Turn Coordinator 1	TC1	1.2	Continuous		
Listing of all other loads presented when Aircraft Master is enabled. This is the current consumed that cannot be reduced without significant impact on aircraft performance or safety margin.					
	Total(Amp-Mins): 216				
Lighting					
Nav Lights	Lights-Nav	3.6	Continuous	Night	
Strobe	Lights-Str	1.4	Continuous	Day/Night	
Taxi/Land	Lights-Land	9.8	Intermittent	Departure/Landing	
Air Conditioning					
Cooling Fan	AC-Fan	12.0	Continuous	AC On	
Avionics					
Audio	Aud	0.5	Continuous		
Com1	Com1	0.9	Continuous	5% Transmit Duty Cycle	
Com2	Com2	0.9	Continuous	5% Transmit Duty Cycle	
Nav1	Nav1	0.5	Continuous		
Nav2	Nav2	0.5	Continuous		
Autopilot	AP	2.1	Continuous	FD/AP Engaged	
TXP	TXP	1.4	Continuous		
Inverter	Inv	2.1	Continuous		
Etc…					
	Total(Amp-Mins): 2142				

The total consumption is then analyzed for expected loads under Taxi, Take-Off & Land (Night), Cruise (Night), and Landing (Night) conditions. From this data the performance of the electrical system and safety margins are found. Further, the expected current demands must be compared to the available sources in a degraded condition i.e. Abnormal and Emergency. It is here that triage among systems must take place. Simply put, you leave on only what is needed to assure that "the successful completion of a flight is never seriously in doubt". Most lighting, avionics, anti-icing, even flap operation is non-essential to the safe completion of a flight under such conditions.

This leaves us with Emergency Battery operation. How long can an electrical system function on battery power after the five minute total current drain allowance imposed by regulation? I asked this to a private pilot who regularly flies IFR. His aircraft has a 14 volt electrical system and he does know that there is a 1 volt drop across the avionics master relay and associated wiring. There is only 12.7 VDC during cruise on the avionics buss when his main buss shows 13.7 VDC. He has no idea how long he can communicate and navigate should his only alternator fail and what the electrical demands are from his equipment. He is not alone. This is why we should proceed with our study of Electrical Load Analysis.

Next Month: Battery Buss calculations