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Standard Guide for Aircraft Electrical Load and Power Source Capacity Analysis[1]

This standard is issued under the fixed designation F2490; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This guide covers how to prepare an electrical load analysis (ELA) to meet Federal Aviation Administration (FAA) requirements.

1.2 This guide is intended to address aircraft level electrical load analysis. Electric propulsive power load analysis was not considered in the development of this guide.

1.3 The values ~~given~~stated in SI units are to be regarded as ~~the~~ standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *FAA Aeronautics and Space Airworthiness Standards:*[2]

14 CFR 23.1309 Normal, Utility, Acrobatic, and Commuter Category Airplanes—Equipment, Systems, and Installations
14 CFR 23.1351 Normal, Utility, Acrobatic, and Commuter Category Airplanes—General
14 CFR 23.1353 Normal, Utility, Acrobatic, and Commuter Category Airplanes—Storage Battery Design and Installation
14 CFR 23.1419 Normal, Utility, Acrobatic, and Commuter Category Airplanes—Ice Protection
14 CFR 23.1529 Normal, Utility, Acrobatic, and Commuter Category Airplanes—Instructions for Continued Airworthiness
14 CFR 91 General Operating and Flight Rules
14 CFR 135.163 Operating Requirements: Commuter and On Demand Operations and Rules Governing Persons on Board Such Aircraft—Equipment Requirements: Aircraft Carrying Passengers under IFR

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *abnormal electrical power operation (or abnormal operation), n*—occurs when a malfunction or failure in the electric system has taken place and the protective devices of the system are operating to remove the malfunction or failure from the remainder of the system before the limits of abnormal operation are exceeded.

3.1.1.1 *Discussion*—

The power source may operate in a degraded mode on a continuous basis when the power characteristics supplied to the using equipment exceed normal operation limits but remain within the limits for abnormal operation.

3.1.2 *alternate source, n*—second power source that may be used instead of the normal source, usually on failure of the normal source.

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[2] Available from U.S. Government ~~Printing Office Superintendent of Documents,~~ Publishing Office (GPO), 732 N. Capitol St., NW, ~~Mail Stop: SDE,~~ Washington, DC ~~20401.~~20401, http://www.gpo.gov.

3.1.2.1 *Discussion—*

The use of alternate sources creates a new load and power configuration and, therefore, a new electrical system that may require separate source capacity analysis.

3.1.3 *cruise, n—*condition during which the aircraft is in level flight.

3.1.4 *electrical source, n—*electrical equipment that produces, converts, or transforms electrical power.

3.1.5 *electrical system, n—*consists of an electrical power source, the electrical wiring interconnection system, and the electrical load(s) connected to that system.

3.1.6 *emergency electrical power operation (or emergency operation), n—*condition that occurs following a loss of all normal electrical generating power sources or another malfunction that results in operation on standby power (batteries or other emergency generating source such as an auxiliary power unit (APU) or ram air turbine (RAT)) only, or both).

3.1.7 *ground operation and loading, n—*time spent in preparing the aircraft before the aircraft engine starts.

3.1.7.1 *Discussion—*

During this period, the APU, internal batteries, or an external power source supplies electrical power.

3.1.8 *landing, n—*condition starting with the operation of navigational and indication equipment specific to the landing approach and following until the completion of the rollout.

3.1.9 *nominal rating, n—*this rating of a unit power source is its nameplate rating and is usually a continuous duty rating for specified operating conditions.

3.1.10 *normal ambient conditions, n—*typical operating conditions such as temperature and pressure as defined by the manufacturer's technical documentation.

3.1.11 *normal electrical power operation (or normal ~~operation) ,~~ operation), n—*assumes that all the available electrical power system is functioning correctly with no failures or within the Master Minimum Equipment List (MMEL) limitations, if a MMEL has been approved (for example, direct current (DC) generators, transformer rectifier units, inverters, main batteries, APU, and so forth).

3.1.12 *normal source, n—*provides electrical power throughout the routine aircraft operation.

3.1.13 *takeoff and climb, n—*condition starting with the takeoff run and ending with the aircraft leveled off and set for cruising.

3.1.14 *taxi, n—*condition from the ~~aircraft's~~aircraft's first movement under its own power to the start of the takeoff run and from completion of landing rollout to engine shutdown.

4. Significance and Use

4.1 To show compliance with 14 CFR 23.1351, you must determine the electrical system capacity.

4.2 14 CFR 23.1351(a)(2) states that:

4.2.1 For normal, utility, and acrobatic category airplanes, by an electrical load analysis or by electrical measurements that account for the electrical loads applied to the electrical system in probable combinations and for probable durations; and

4.2.2 For commuter category airplanes, by an electrical load analysis that accounts for the electrical loads applied to the electrical system in probable combinations and for probable durations.

4.3 The primary purpose of the electrical load analysis (ELA) is to determine electrical system capacity (including generating sources, converters, contactors, bus bars, and so forth) needed to supply the worst-case combinations of electrical loads. This is achieved by evaluating the average demand and maximum demands under all applicable flight conditions. A summary can then be used to relate the ELA to the system capacity and can establish the adequacy of the power sources under normal, abnormal, and emergency conditions.

NOTE 1—The ELA should be maintained throughout the life of the aircraft to record changes to the electrical system, which may add or remove electrical loads to the system.

4.4 The ELA that is produced for aircraft-type certification should be used as the baseline document for any subsequent changes. When possible, the basic format of the original ELA should be followed to ensure consistency in the methodology and approach.

4.5 The original ELA may be lacking in certain information, for instance, time available on emergency battery. It may be necessary to update the ELA using the guidance material contained in this guide.

5. Basic Principles

5.1 A load analysis is essentially a summation of the electric loads applied to the electrical system during specified operating conditions of the aircraft. The ELA requires the listing of each item or circuit of electrically powered equipment and the associated power requirement. Note that the power requirement for an item may have several values, depending on the utilization for each phase of aircraft operation.

5.2 To arrive at an overall evaluation of electrical power requirement, it is necessary to give adequate consideration to transient demand requirements, which are of orders of magnitude or duration to impair system voltage or frequency stability, or both, or to exceed short-time ratings of power sources, that is, intermittent/momentary and cyclic loads. This is essential, since the ultimate use of an ~~aircraft’s~~aircraft’s ELA is for the proper selection of characteristics and capacity of power-source components and the resulting assurance of satisfactory performance of equipment under normal, abnormal, and emergency operating power conditions.

5.3 A large majority of general aviation aircraft uses only DC power. If an aircraft also uses AC power, the ELA will have to include the AC loads as well.

6. Procedure for Preparation of Electrical Load Analysis

6.1 *Content*—The load and power source capacity analysis report should include the following sections:

6.1.1 Introduction,

6.1.2 Assumptions and Criteria,

6.1.3 Load Analysis—Tabulation of Values,

6.1.4 Emergency and Standby Power Operation, and

6.1.5 Summary and Conclusions.

6.2 *Introduction:*

6.2.1 The introduction to the ELA report should include information to assist the reader in understanding the function of the electrical system with respect to the operational phases of the aircraft.

6.2.2 Typically, the introduction to the ELA should contain the following:

6.2.2.1 Brief description of aircraft type, which may also include the expected operating role for the aircraft;

6.2.2.2 Electrical system operation, which describes normal, abnormal, and emergency operations, bus configuration with circuit breakers, and connected loads for each bus. A copy of the bus wiring diagram or electrical schematic should also be included in the report;

6.2.2.3 Generator, alternator, and other power source description and related data (including such items as battery discharge curves, inverter, emergency battery, and so forth). Typical data supplied for power sources would be as shown in Table 1;

6.2.2.4 Operating logic of system (for example, automatic switching, loading shedding, and so forth); and

6.2.2.5 List of installed equipment.

6.3 *Assumptions and Criteria*—All assumptions and design criteria used for the analysis should be stated in this section of the ELA. For example, typical assumptions for the analysis may be identified as follows:

6.3.1 Most severe loading conditions and operational environment in which the airplane will be expected to operate are assumed to be night and in icing conditions;

6.3.2 Momentary/intermittent loads, such as electrically operated valves, that open and close in a few seconds are not included in the calculations;

6.3.3 Motor load demands are shown for steady-state operation and do not include starting inrush power. The overload ratings of the power sources should be shown to be adequate to provide motor starting inrush requirements;

6.3.4 Intermittent loads such as communications equipment (radios, for example, VHF/HF communication systems) that may have different current consumption depending on operating mode (that is, transmit or receive);

6.3.5 Maximum continuous demand of the electrical power system must not exceed 100 % of the load limits of the alternator(s) or generator(s) that are equipped with current monitoring capability;

6.3.6 Cyclic loads such as heaters, pumps, and so forth (duty cycle); and

6.3.7 Estimation of load current, assuming a voltage drop between bus bar and load.

TABLE 1 Typical Data for Power Sources

Identification	1	2	3
Item	DC Generator	Inverter	Battery
Number of units	2	1	1
Continuous rating	250 A	300 VA (total)	35 Ah
(Nameplate)	. . .	. . .	. . .
~~5-s rating~~	~~400 A~~	~~. . .~~	~~. . .~~
5 s rating	400 A	. . .	. . .
~~2-min rating~~	~~300 A~~	~~. . .~~	~~. . .~~
2 min rating	300 A	. . .	. . .
Voltage	30 V	115 VAC	24 VDC
Frequency	. . .	400 Hz	. . .
Power factor	. . .	0.8	. . .
Manufacturer	ABC	XYZ	ABC
Model number	123	456	789
Voltage regulation	±0.6 V	±2 %	. . .
Frequency regulation	. . .	400 Hz ± 1 %	. . .

6.4 *Load Analysis—Tabulation of Values*—A typical load and power source analysis would identify the following details in tabular form:

6.4.1 *Connected Load Table*—See Appendix X1.

6.4.1.1 *Aircraft Bus*—Identify the appropriate electrical bus being evaluated. In a multiple bus configuration, there will be a set of tables for each bus (that is, DC Bus 1, DC Bus 2, AC Bus 1, Battery Bus, and so forth).

6.4.1.2 *Condition of Power Sources*—Normal, abnormal (abnormal conditions to be specified, for example, one generator inoperative, two generators inoperative, and so forth), and emergency.

6.4.1.3 *Aircraft Operating Phases*—The following aircraft operating phases should be considered for the ELA. Assume "night" conditions as the worst-case scenario.

NOTE 2—Icing conditions should be considered for worst-case scenarios if the aircraft is approved for flight into known icing in accordance with 14 CFR 23.1419. However, in some cases, the icing system is deactivated or not installed, so icing may not always be the worst-case.

6.4.1.4 *Permissible Nonserviceable Conditions*—The analysis should also identify permissible nonserviceable conditions likely to be authorized in the MMEL, if approved, during the certification of the airplane and should include calculations appropriate to these cases. All MMEL items must be accounted for in the load analysis to ensure that the electrical system capacity is not exceeded when all items are functional.

6.4.1.5 *Circuit Breaker*—Identify each circuit breaker by circuit name or identification number.

6.4.1.6 *Load at Circuit Breaker*—The ampere loading for each circuit.

6.4.1.7 *Operating Time:*

(1) The operating time is usually expressed as a period of time (seconds/minutes) or may be continuous, as appropriate. Equipment operating time is often related to the average operating time of the aircraft. If the "on" time of the equipment is the same or close to the average operating time of the aircraft, then it could be considered that the equipment is operating continuously for all flight phases.

(2) In such cases in which suitable provisions have been made to ensure that certain loads cannot operate simultaneously, or there is reason for assuming certain combinations of load will not occur, appropriate allowances may be made. Adequate explanation should be given in the summary.

(3) In some instances, it may be useful to tabulate the data using a specified range for equipment operating times, such as follows:

~~5-s Analysis~~	~~All loads that last longer than 0.3 s should be entered in this column.~~
5 s Analysis	All loads that last longer than 0.3 s should be entered in this column.
~~5-min Analysis~~	~~All loads that last longer than 5 s should be entered in this column.~~
5 min Analysis	All loads that last longer than 5 s should be entered in this column.
Continuous Analysis	All loads that last longer than 5 min should be entered in this column.

(4) Alternatively, the equipment operating times could be expressed as actual operating time of equipment in seconds or minutes or as continuous operation. In the example given in Appendix X1, the approach taken is to show either continuous operation or to identify a specific operating time in seconds/minutes.

6.4.1.8 *Condition of Aircraft Operation*—Phase of preflight and flight (such as ground operation and loading, taxi, takeoff, cruise, and land). For aircraft, the conditions in Table 2 could be considered.

TABLE 2 Condition of Aircraft Operation

Ground operations and loading	15 min typically
Engine start	5 min typically
Taxi	10 min typically
Takeoff and climb	20 min typically
Cruise	as appropriate for aircraft type
Landing	20 min typically

6.4.2 *Calculations:*

6.4.2.1 The following equations can be used to estimate total current, total current rate, and average demand for each of the aircraft operating phases (ground operation and loading, engine start, taxi, takeoff and climb, cruise, and landing):

$$\text{Total Current (A)} = \text{Sum of All Current Loads} \quad (1)$$

$$\text{Operating at a Given Time}$$

$$\text{Total Current Rate } (\text{A} - \text{min}) = \quad (2)$$

$$\text{Number of Units Operating Simultaneously} \times \text{Current per Unit (A)} \times$$

$$\text{Operating Time (min)}$$

$$\text{Average Demand or Average Load (A)} = \text{Total Current } (\text{A} - \text{min}) \div \text{Duration of Ground or Flight Phase (min)} \quad (3)$$

6.4.2.2 It can be considered that at the start of each operating period (for example, taxi, takeoff, and so forth), all equipment that operates during that phase is switched "on," with intermittent loads gradually being switched "off."

6.4.3 *Additional Considerations for Non-Ohmic or Constant Power Devices (for example, Inverters)*—In some cases, the currents drawn at battery voltage (for example, 20 VDC to 24 VDC) are higher than at the generated voltage (for example, 28 VDC) and will influence the emergency flight conditions on battery. However, for resistive loads, the current drawn will be reduced because of the lower battery voltage.

6.4.4 *System Regulation:*

6.4.4.1 The system voltage and frequency should be regulated to ensure reliable and continued safe operation of all essential equipment while operating under the normal and emergency conditions, taking into account the voltage drops that occur in the cables and connections to the equipment.

6.4.4.2 The defined voltages are those supplied at the equipment terminals and allow for variation in the output of the supply equipment (for example, generators, alternators, and batteries), as well as voltage drops caused by cable and connection resistance.

NOTE 3—Voltage drop between bus bar and equipment should be considered in conjunction with bus bar voltages under normal, abnormal, and emergency operating conditions in the estimation of the terminal voltage at the equipment (that is, reduced bus bar voltage in conjunction with cable volt drop could lead to malfunction or shutdown of equipment).

6.4.5 *Load Shedding*—Following the loss of a generator/alternator, it is assumed a ~~5-min~~ 5 min period will elapse before any manual load shedding by the flight crew, provided that the failure warning system has clear and unambiguous attention-getting characteristics as required by 14 CFR 23.1351(c)(4). Any automatic load shedding is assumed to take place immediately.

NOTE 4—You should use 10 min where no flashing warning is provided to the flight crew. Where automatic load shedding is provided, a description of the load(s) that will be shed should be provided with any specific sequencing, if applicable.

6.5 *Emergency or Standby Power Operations:*

6.5.1 Where standby power is provided by non-time-limited sources such as a RAT, APU, and pneumatic or hydraulic motor, the emergency loads should be listed and evaluated such that the demand does not exceed the capacity of the standby power source.

6.5.2 When a battery is used to provide a time-limited emergency supply, an analysis of battery capacity should be undertaken. This should be compared with the time necessary for the particular phase (for example, from gear extension to landing, including rollout) of the flight in which batteries are used instead of normal electrical power sources.

6.5.3 *Five Minutes of Electrical Power Requirement by ~~14 CFR~~ 14 CFR 23.1351(g):*

6.5.3.1 The ELA must show the airplane can operate safely in visual flight rules (VFR) conditions and initially at the maximum certificated altitude for a period of not less than 5 min during emergency operation conditions.

6.5.4 *Thirty Minutes of Electrical Power Requirement by ~~14 CFR~~ 14 CFR 23.1353(h):*

6.5.4.1 This section addresses the 30 min of electrical power requirement under 14 CFR 23.1353(h) incorporated by Amendment 23-49. This guide only addresses the requirement of 14 CFR 23.1353(h) and not the electrical power requirements that an airplane can operate safely in VFR conditions under 14 CFR 23.1351(g) or the electrical power sources requirements in 14 CFR 135.163.

6.5.4.2 The requirements of 14 CFR 23.1353(h) are as follows: In the event of a complete loss of the primary electrical power generating system, the battery must be capable of providing at least 30 min of electrical power to those loads that are essential to continued safe flight and landing. The ~~30-min~~30 min time period includes the time needed for the pilots to recognize the loss of generated power and take appropriate load shedding action.

6.5.4.3 Refer to the guidance in FAA Advisory Circular ~~14 CFR~~ 14 CFR 23.1309-1C for determining the loads that are essential to continued safe flight and landing. Continued safe flight and landing is defined as follows: This phrase means that the airplane is capable of continued controlled flight and landing, possibly using emergency procedures, without requiring exceptional pilot skill or strength. Upon landing, some airplane damage may occur as a result of a failure condition.

6.5.4.4 The 30-min power bus should include all systems that could cause a catastrophic failure condition under 14 CFR 23.1309, Failure Hazard Assessment. In some cases, it may not be practical to include all systems on the 30-min power bus that could cause a catastrophic failure condition. For example, systems with large heating loads for ice protection may not be included on the 30-min electrical power bus; however, the possible hazards that could cause catastrophic failure conditions should be minimized.

6.5.4.5 To minimize the hazard is to reduce, lessen, or diminish to the least practical amount with current technology and materials. The least practical amount is that point at which the effort to further reduce a hazard significantly exceeds any benefit in terms of safety derived from that reduction. Additional efforts would not result in any significant improvements to safety and would inappropriately add to the cost of the product.

6.5.4.6 A review of aircraft operating rule equipment requirements, the Airplane Flight Manual (AFM) and the Type Certificate Data Sheet must be made for any additional essential items for continued safe flight and landing.

6.5.4.7 Tests and analyses should be considered for determining the rated operating capacity of the battery, the normal service life, and the continued airworthiness requirement of 14 CFR 23.1529.

6.5.4.8 For these tests and analyses, the following should be established:

(1) For the operating capacity, the discharge rate, temperature, and end-point voltage, and

(2) For the airworthiness requirement, the inspection schedule, useful battery life, and end of life.

6.5.5 *Battery Condition Calculations*—Battery capacity is the ability to produce a specified amount of current for a specified amount of time and is estimated from either a practical test, which involves applying typical aircraft loads for a period of time, or by calculation. It is important that considerations be given to the initial conditions of the aircraft (for example, condition and state of charge of battery).

6.5.6 *Calculation:*

6.5.6.1 An assessment of the battery performance requires a load analysis of the expected loads compared to the discharge figures of the battery manufacturer's discharge curves and data sheets. This will show whether the battery has the capacity to supply the required power when needed.

6.5.6.2 The capacity of a battery is expressed as:

$$\text{Rate of discharge (A)} \times \text{Time to discharge (h) to a specified voltage level} \tag{4}$$

6.5.6.3 Normally expressed in A-h, but for a typical load analysis, calculations are usually expressed in A-min (that is, A-h × 60). However, this is not a linear function. With heavier discharge currents, the discharge time deceases more rapidly so that the power available is less (that is, reduced efficiency).

6.5.6.4 To make an accurate assessment of battery duration, reference should be made to the manufacturer's discharge curves. However, it is recognized that these may not be available, and certain assumptions and approximations are provided to allow for this case.

6.5.6.5 Because of the problem of definition of capacity, it is first necessary to ensure that all calculations are based on the ~~1-h~~ 1 h rate. Some manufacturers, however, do not give this on the nameplate and quote the ~~5-h~~ 5 h rate. For these calculations, as a general rule, it may be assumed that the ~~1-h~~ 1 h rate is 85 % of the quoted ~~5-h~~ 5 h rate.

6.5.6.6 Battery capacity at the ~~1-h~~ 1 h rate requires the battery to maintain a ~~10-V~~ 10 V minimum voltage or end point voltage for a ~~12-V~~ 12 V battery or a ~~20-V~~ 20 V minimum voltage for a ~~24-V~~ 24 V battery for a period of 85 % of the ~~1-h~~ 1 h rate (that is, 60 × ~~.85~~0.85 or 51 min).

NOTE 5— If the airframe or equipment manufacturer specifies a different end point voltage, then that must be used.

6.5.6.7 Following a generator system failure and before the pilot has completed load shedding; the battery may be subjected to high discharge currents with a resultant loss of efficiency and capacity. To make allowance for such losses, the calculated power consumed during the preload shed period should be factored by an additional 20 % if the average discharge current in amps is numerically more than twice the ~~1-h~~ 1 h rating of the battery.

6.5.6.8 Note that the discharge rate of a lead-acid battery is different than that of a nickel-cadmium battery. Fig. 1 shows a typical discharge curve for lead-acid and nickel-cadmium battery at a 5-A discharge rate.

6.5.6.9 Unless otherwise stated, for the purpose of this calculation, a battery capacity at normal ambient conditions of 80 % of the datasheet-rated capacity at the ~~1-h~~ 1 h rate, and a 90 % state of charge, may be assumed. This results in a capacity of approximately 72 % (90 % of 80 %) of nominal datasheet-rated capacity at ~~+20°C.~~ +20 °C. This is typically rounded to 75 % for calculations. The allowance for battery endurance presumes that the requirements for periodic battery maintenance have been accomplished in accordance with the Instructions for Continued Airworthiness. Extreme ambient conditions such as extreme cold should be factored in accordance with the manufacturer's technical information.

6.5.7 *Battery-Charging Current Analysis*—The charging current for any aircraft battery is based on the total elapsed time from the beginning of the charge and is calculated using the following formula:

$$I = A \times C \tag{5}$$

where:

I = average charging current in A,
~~A = A-h capacity of the battery based on the 1-h discharge rate, and~~
A = A-h capacity of the battery based on the 1 h discharge rate, and

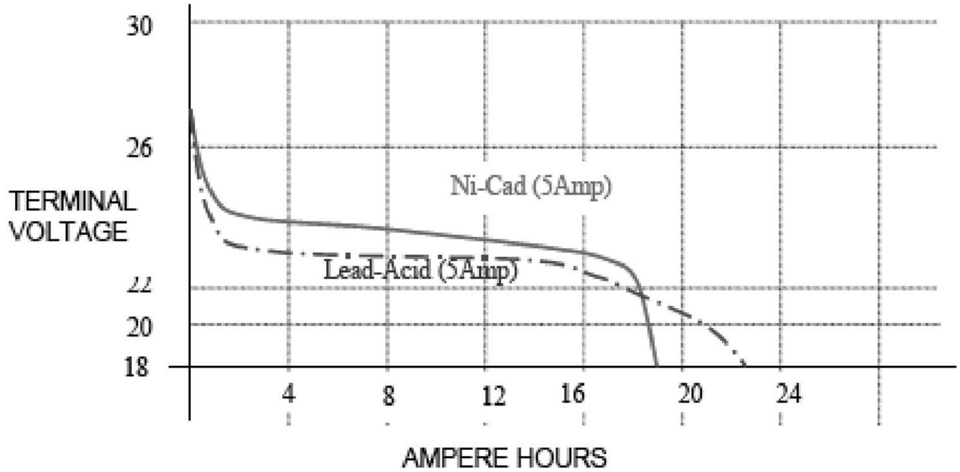

FIG. 1 Typical Discharge Rates of Lead-Acid and Nickel-Cadmium Batteries

C = battery-charging factor taken from the battery-charging curve supplied with battery data (graphical data).

6.5.8 *Example of How to Calculate the Battery Duration:*

6.5.8.1 Check the nameplate capacity of the battery and assume 75 % is available (for example, 12 A-h = 720 A-min). Therefore, 75 % is equal to 540 A-min.

6.5.8.2 Estimate the normal or preload shed cruise consumption (assume worst-case cruise at night). For example, 15 A (15 A × 5 min = 75 A-min). This assumes 5 min for pilot to shed essential loads following a low-voltage warning. Any automatic load shedding can be assumed to be immediate and need not be considered in the preload shed calculations.

6.5.8.3 Estimate the minimum cruise load necessary to maintain flight after the generator/alternator has failed (for example, 10 A).

6.5.8.4 Estimate the consumption required during the landing approach (for example, 20 A for 5 min (100 A-min)). The cruise duration is therefore:

$$\frac{\text{Battery Capacity} - (\text{Preload Shed} + \text{Landing Load})}{\text{Cruise Load}} = \frac{(a) - ((b) + (d))}{(c)} = \frac{540 - (75 + 100)}{10} = \frac{365}{10} = 36.5\text{min} \quad (6)$$

$$\text{Total Duration} = \text{Preload Shed Cruise Time} + \text{Cruise Duration} + \text{Landing Time Total Duration} = 5 + 36.5 + 5 = 46.5\text{min} \quad (7)$$

6.6 *Summary and Conclusions:*

6.6.1 *Summary:*

6.6.1.1 The ELA summary should provide evidence that for each operating condition, the available power can meet the loading requirements with adequate margin for both peak loads and maximum continuous loads. This should take into account both the normal and abnormal (including emergency) operating conditions.

6.6.1.2 For AC power systems, these summaries should include power factor and phase loadings.

6.6.2 *Conclusions*—The conclusions should include statements that confirm that the various power sources can satisfactorily supply electrical power to necessary equipment during normal and abnormal operation under the most severe operating conditions as identified in the analysis. You should confirm that the limits of the power supplies are not exceeded.

7. Example of an Electrical Load Analysis

7.1 As stated previously, the ELA is designed to show the capability of the electrical system under various ground and flight operating conditions. The analysis should verify that the electrical power sources would provide power to all circuits of the aircraft.

7.2 The example provided is intentionally oversimplified to clarify the process involved. The applicable design organization is responsible for the selection of the method of analysis.

7.3 A simple electrical load utilization and analysis for an aircraft is provided in Appendix X1.

8. Practical Test (Ground or Air)

8.1 Practical testing may be used as a method of verifying certain loads and would be appropriate as supporting data to the ELA.

9. Electrical Measurement Method for Load Determination

9.1 Section 23.1351(a)(2) allows normal, utility, and acrobatic category airplanes to determine electrical loads by measurement. Measurements must account for loads applied to the electrical system in probable combinations and durations for the aircraft.