
SUBJECT: ELECTRICAL LOAD ANALYSIS

DATE: 24/07/2015

1. PURPOSE

This Circular is issued to clarify the need and occasions where an Electrical Load Analysis (ELA) is required and to identify the particular regulations mandating those requirements.

2. APPLICABILITY

This Circular applies to all aircraft fitted with an electrical system.

3. DEFINITIONS

3.1.1 For the purpose of this technical circular the following definitions shall apply:

- (1) **Electrical system.** An electrical system consists of an electrical power source, its power distribution system and the electrical load connected to that system.
- (2) **Normal electrical power operation** (or normal operation). Normal operating conditions assumes that all of the available electrical power system is functioning correctly within Master Minimum Equipment List (MMEL) limitations (e.g. AC and/or DC Generators, Transformer Rectifier Units, Inverters, Main Batteries, APU etc.).
- (3) **Abnormal electrical power operation** (or abnormal operation). Abnormal operation 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 the failure from the remainder of the system before the limits of abnormal operation are exceeded. The power source may operate in a degraded mode on a continuous basis where the power characteristics supplied to the utilization equipment exceed normal operation limits but remain within the limits for abnormal operation.
- (4) **Emergency electrical power operation** (or emergency operation). Emergency operation is a condition that occurs following a loss of all normal electrical generating power sources or other malfunction that results in operation on standby power (batteries and or other emergency generating source such as an APU or Ram Air Turbine (RAT)) only. Also identified as 'operation without normal electrical power' in FAR §§ 23.1351(d), 25.1351(d), 27.1351(d) and 29.1351(d).

4. BACKGROUND

4.1.1 The purpose of an ELA is to ensure that the demand on the aircraft's electrical system does not result in the undesirable situation that, during operations in the most onerous circumstances,

the electrical system would be inadequate in meeting those system demands or where the emergency reserves are insufficient to meet the requirements during an emergency.

Note: It is important to note that the ELA is a 'living' document and as such should be maintained throughout the life of the aircraft to record changes to the connected loads, which may be added or removed by modification or changes in operational procedures.

- 4.1.2 The ELA that is produced for Aircraft Type Certification is the baseline document for any subsequent changes. If possible, the basic format for the ELA should be maintained to ensure consistency in the methodology and approach.
- 4.1.3 Most aircraft that are registered in Cabo Verde have been built and certified to an accepted design standard. Whilst Attachment 1 has some examples owners/operators need to confirm the particular regulation applicable to their aircraft. When compliance to the nominated standard has been established, a Certificate of Airworthiness (C of A) is issued.
- 4.1.4 During the development of any modification that may have an effect on an aircraft's electrical power system, the design organization must ensure that that system has the capacity to accommodate that change.
- 4.1.5 An ELA needs to be performed to establish the baseline electrical capacity of the aircraft. Whilst the form this analysis takes is determined by the design organization and will be dependent on the type, age and complexity of the aircraft, it still needs to be documented. From this baseline, it is the modification designer's responsibility to establish whether the modification is viable and remains compliant with the design standard for which the C of A was issued against.
- 4.1.6 The aircraft manufacturer's original ELA, if applicable is acceptable provided there have been no modifications to the original delivered configuration. There is no requirement to conduct an ELA prior to such time that a modification is to be incorporated.

5. BASIC PRINCIPLES

- 5.1.1 The principle of an ELA demands the listing of each item or circuit of electrically powered equipment and the associated power requirement. The power requirement for a piece of equipment or circuit may have several values depending on the utilization during each phase of aircraft operation.
- 5.1.2 In order to arrive at an overall evaluation of electrical power requirement, adequate consideration should be given to transient demand requirements which are of a capacity or duration to impair system voltage and/or frequency stability, or to exceed short time ratings of power sources (i.e. intermittent/momentary and cyclic loads). This is important, since the ultimate use of an aircraft's ELA is for the proper selection of characteristics and capacity of power-source components and resulting assurance of satisfactory performance of equipment, under normal, abnormal and emergency operating power conditions.

6. RECOMMENDATION

- 6.1.1 Aircraft owners and registered operators and Approved Maintenance Organization (AMO) need to be aware of their individual responsibilities with regard to ELAs as follows:

- (1) Prior to issue of a C of A to a Cabo Verde registered aircraft, the authority, as part of the airworthiness assessment, needs to ensure that the aircraft's electrical system is compliant with the nominated design standard. New aircraft imported directly from the manufacturer or a used aircraft that has a valid export C of A from a recognized airworthiness authority can reasonably be assumed to be compliant.
- (2) The compilation of an ELA prior to the incorporation of a modification is mandatory for all aircraft fitted with an electrical system and have been issued a C of A under the applicable design standards unless there is a current ELA available. This is to ensure that the modification is fit for purpose and to demonstrate compliance with the applicable regulation, examples of have been included in Attachment 1 to this TC.
- (3) The aircraft owner or registered operator is responsible to ensure that the appropriate aircraft records are maintained. It is the operator's responsibility to ensure the continuing relevance of that ELA – when modifications are incorporated the operator must ensure that it is updated. This will make sure that during the next modification design phase the system capacity will be assessed against the actual aircraft configuration.
- (4) The AMO may perform the ELA as a task as part of the verification steps identified in an engineering order or as a maintenance task if requested by the operator.
- (5) The ELA and the data developed by the design organization for the aircraft being modified must be approved by the authority of the State of Design.
- (6) The ELA and the data to the aircraft being modified must be submitted to the AAC for acceptance.

The image shows the official stamp of the AAC (Agência de Aviação Civil do Cabo Verde) and a handwritten signature in blue ink. The stamp is rectangular with a dotted border and contains the AAC logo (three stylized 'A's) and the text 'AGÊNCIA DE AVIAÇÃO CIVIL', 'Civil Aviation Authority', and 'Praia / Cabo Verde'. A blue line from the signature points to the stamp.

João dos Reis Monteiro
President of the Board

ANNEX A - EXAMPLES OF DESIGN STANDARDS

All aircraft that are registered in Cabo Verde must have been built and certified to a design standard accepted to the AAC. The following are examples, in part, of current and past standards applicable to the electrical systems of aircraft:

Civil Air Regulation (of the United States) 3.682 at Amendment 14

(a) Electrical power sources, their transmission cables, and their associated control and protective devices, shall have sufficient capacity to furnish the required power at the proper voltage to all load circuits essential to the safe operation of the airplane.

(b) Compliance with paragraph (a) of this section shall be shown by means of an electrical load analysis, or by electrical measurements, which take into account all electrical loads applied to the electrical system, in probable combinations and for probable durations.

FAA/JAA/CS § 23.1351 § 27.1351

(a) Electrical system capacity. Each electrical system must be adequate for the intended use. In addition —

(1) Electric power sources, their transmission cables, and their associated control and protective devices, must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation; and

(2) Compliance with paragraph (a)(1) of this section must be shown as follows —

(i) 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

(ii) 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.

FAA/JAA/CS § 25.1351 § 29.1351

(a) Electrical system capacity. The required generating capacity, and number and kinds of power sources must —

(1) Be determined by an electrical load analysis; and

(2) Meet the requirements of §25.1309