



# AEROSPACE RECOMMENDED PRACTICE

**ARP1816™****REV. D**

Issued 1984-09  
Revised 2015-07  
Reaffirmed 2020-09

Superseding ARP1816C

(R) Charger for Battery Powered Ground Support Equipment

## RATIONALE

A review of ARP1816C revealed that it excluded charging technology commonly referred to as opportunity charging. ARP1816C was revised to include a section describing this charging technology.

### 1. SCOPE

This SAE Aerospace Recommended Practice (ARP) describes three general types of Ground Support Equipment (GSE) battery chargers. The battery charger typically requiring up to 8 hours to recharge a 100% discharged battery, hereafter called "Conventional Charger." A charger, hereafter called "Opportunity Charger," which has the ability to charge at a slightly faster rate than a conventional charger. A charger, hereafter called "Fast Charger," which has the ability to charge at a much faster rate than a conventional charger. Recommendations that apply to all types will refer generically to "charger."

### 2. REFERENCES

#### 2.1 APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

##### 2.1.1 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, [www.ansi.org](http://www.ansi.org).

ANSI C84.1-1995 Voltage Ratings for Electrical Power Systems and Equipment (60 Hz)

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SAE WEB ADDRESS:

For more information on this standard, visit  
<https://www.sae.org/standards/content/ARP1816D>

### 2.1.2 BCI Publications

Available from Battery Council International, 330 North Wabash Avenue, Suite 2000, Chicago, IL 60611, Tel: 312-644-6610, [www.batteryCouncil.org](http://www.batteryCouncil.org).

BCIS-16 Standard for Deep Cycle Battery Chargers

BCIS-18 Standard for Deep Cycle Fast Battery Chargers.

### 2.1.3 CSA Publications

Available from CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3, Tel: 416-747-4000, [www.csa-international.org](http://www.csa-international.org).

CAN/CSA-C22.2 NO. 107.2-01 Battery Chargers

### 2.1.4 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, [www.ul.com](http://www.ul.com).

UL 1564 Industrial Battery Chargers

## 2.2 Definitions

2.2.1 AMPACITY: The current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

## 3. GENERAL DESCRIPTION

### 3.1 Charger

3.1.1 The basic charger shall be UL listed (UL 1564 Industrial Battery Chargers) or CSA certified (CAN/CSA-C22.2 NO. 107.2-01 Battery Chargers) except as modified for outdoor use or other special options.

3.1.2 Adequate overload protection shall be provided in both AC and DC lines.

3.1.3 The charger input voltage shall be single or three-phase and purpose built to match the electrical supply. Dual voltage transformers with easy to change transformer terminals may also be used provided changeover instructions are permanently affixed inside the charger in a readily visible location through the open door. Three phase chargers are recommended.

3.1.4 Nominal control voltage shall be 24 VAC or less.

3.1.5 A transformer shall be used as the primary means of minimizing AC shock hazards and the following points shall be considered.

3.1.5.1 The transformer shall have its primary winding electrically isolated from its secondary winding and, if required by UL, shall be varnish impregnated and baked to exclude moisture.

3.1.5.2 Means shall be provided to prevent the possibility of primary voltage being present in the secondary circuit. This shall be accomplished by either of the following:

3.1.5.2.1 A grounded electrostatic or Faraday shield shall be placed between the primary and secondary windings. This shield shall be made of copper or aluminum and shall have at least the ampacity of the primary conductor if the primary conductor is smaller than No. 6 AWG (16 mm<sup>2</sup>). If the primary conductor is No. 6 AWG (16 mm<sup>2</sup>) or larger, the shield shall have an ampacity of at least 50% of the primary conductor. If foil is used it shall have a thickness of not less than 0.25 mm (0.010 inch).

3.1.5.2.2 Coil winding methods which provide isolation between input and output circuits.

3.1.6 Each charger shall be completely assembled in a steel case and shall be equipped with properly sized charging cables. Each cable shall have a minimum length of 10 feet (3.05 m) and shall have a properly sized and matched battery connector.

## 3.2 Conventional Charger

3.2.1 The Conventional charger shall be fully capable of charging a 100% discharged, specified battery, automatically, without damage, and in the maximum time of 8 hours or less.

3.2.2 The Conventional charger shall be capable of charging any battery of specified voltage from 80 to 100% of charger rated capacity without adjustment.

3.2.3 The Conventional charger should meet BCIS-16 Standard for Deep Cycle Battery Chargers.

3.2.4 Adjustments may be necessary on the conventional charger, if not temperature compensated, when the battery's electrolyte temperature goes below 32 °F (0 °C) or above 104 °F (40 °C).

## 3.3 Opportunity Charger

3.3.1 The Opportunity Charger shall be capable of applying charge rates up to 25 amps per 100AH of the battery's rated capacity.

3.3.2 The Opportunity charger shall have the ability to automatically shut off when the battery reaches 80% state-of-charge to avoid excessive battery heat.

3.3.3 The Opportunity Charger shall have the option of multiple charge profiles for various battery technologies and various applications.

3.3.4 The Opportunity Charger shall have the option of automatically recognizing the battery type, size and voltage (within its nameplate rating).

3.3.5 The Opportunity Charger shall meet BCIS-18 Standard for Deep Cycle Fast/Battery Chargers

## 3.4 Fast Charger

3.4.1 The Fast charger shall be capable of applying charge rates above 25 amps per 100AH of the battery's rated capacity.

3.4.2 The Fast charger shall monitor the battery's temperature and adjust its output to prevent overheating the battery while charging.

3.4.3 The Fast Charger shall have the option of automatically recognizing the battery type, size, and voltage (within its nameplate rating).

3.4.4 The Fast Charger shall have the option of multiple charge profiles for various battery technologies and various applications.

3.4.5 The Fast Charger shall meet BCIS-18 Standard for Deep Cycle Fast/Battery Chargers.

#### 4. REGULATION AND EFFICIENCY

- 4.1 The charger internal regulation shall compensate for varying AC line and load variations as indicated in ANSI C84.1-1995 and regulate DC finish voltage to a maximum of  $\pm 1\%$ .
- 4.2 Efficiency over a full charge cycle shall be a minimum of 85% (KWH out/KWH in) for 36 V and above chargers.
- 4.3 Power factor shall average a minimum of 0.6 over the full range of output (KW in/KVA in) for SCR type chargers and 0.9 for all other types (ferroresonant, SMPS, etc.).

#### 5. BATTERY CHARGER CONTROLS

- 5.1 The charger is to have a system incorporated to reduce the possibility of battery damage due to over-charging or any other conditions. Failure of any components or group of components shall not cause the charger to operate at its high level for an excessive length of time such as to cause permanent damage to the battery or other components or the charger. The charger shall incorporate a tamper proof design to prevent maladjustment by unauthorized personnel.
- 5.2 Controls shall be provided to insure that the charger is providing the correct charging rate for the battery during the charging period. Factors to be considered in the design of control systems are:
  - 5.2.1 The charger shall start automatically upon connection of the battery without operator action. There shall be sufficient time delay to prevent arcing of the DC power contacts in the battery connector. In the event of AC power interruption the charger shall automatically resume charging when power is restored.
  - 5.2.2 The charger shall be capable of charging the battery at a rate to provide a full charge in a specific time period without damage to the battery.
  - 5.2.3 Upon reaching full charge the charger will automatically shut off.
  - 5.2.4 Provisions shall be included for a manual or automatic equalizing charge.
  - 5.2.5 A manual means shall be provided to interrupt the charging cycle by shutting down the charger.
  - 5.2.6 Other control features may also be included as options.

#### 6. ELECTRICAL COMPONENTS

- 6.1 Heat sinks shall be provided to prevent any rectifying power devices or switching devices from exceeding the manufacturer's temperature rating under maximum load and ambient temperature of 122 °F (50 °C).
- 6.2 All control components shall be rated for continuous duty.
- 6.3 All power transformers shall be insulated to a minimum of Class 180 (replaces Class H).
- 6.4 All diodes, transistors, and control devices shall be protected from damage due to:
  - a. All self-generated transients
  - b. Normal externally applied transients
  - c. Turning the charger on or off at any charging rate or with battery disconnected
  - d. Disconnecting the battery at any charging rate
  - e. Shorting the output terminals
  - f. Battery polarity reversal