# AIRCRAFT BATTERY OWNER/OPERATOR MANUAL

| TITLE<br>AIRCRAFT BATTERY OWNER/ OPERATOR MANUAL | | | | DWG. NO.<br>5-0164 | REVISION<br>B |
|---|---|---|---|---|---|
| CAGE CODE<br>63017 | DRAWN<br>JBT 10/08/04 | CHECKED<br>AT 10/14/04 | APPROVED<br>JBT 10/14/04 | ISSUED<br>AT 09/09/05 | SHEET<br>1 of 27 |

RECORD OF REVISIONS

| Rev No. | Reason for Change | Date | Approved |
|---|---|---|---|
| A | Update | 04/07/05 | JBT |
| B | Revised page 11, section 6, Activation of Dry Charged Batteries | 09/09/05 | JBT |

Please refer to our website, www.concordebattery.com, for current FAA-PMA approved installations of batteries for Type Certified aircraft. The approvals are based on installations in specific aircraft models only.

Aircraft Battery Owner/Operator Manual M-4 has been renumbered to drawing number 5-0164 issued on 10/14/04.

The purpose of this manual is to provide an overview of battery technology and information. It is not intended for use as a maintenance manual and does not replace Concorde Battery Corporation's *Instructions for Continued Air Worthiness Maintenance Manual* Supplements.

## *CONTENTS*

**All Batteries are not created equal**

**Thank you for choosing Concorde...**
Your battery has been hand crafted to the highest quality control standards, ISO 9001: 2000 Certified, for unequaled reliability and durability. Concorde has the most extensive selection of aircraft batteries available. The heavy duty Concorde Aircraft Battery provides greater power for starting at cold temperatures, emergency performance and longer life than any comparable product.

Concorde Aircraft Batteries are preferred over other brands by the majority of the world's Air Forces. Your satisfaction is guaranteed with a transferable warranty that is honored worldwide.

**Please...**
**Recycle your used batteries** by returning them to a drop off site where they may be sent to a secondary lead smelter. Secondary smelters separate the plastic, acid and lead. The lead parts are melted and refined. The purified lead is delivered to battery manufacturers and other industries. The plastic is sent to a reprocessor for manufacture into new plastic products. The acid is collected and either reused or treated. It is possible that original battery components could be used again and again to manufacture new lead acid batteries.

CAUTION: Aluminum cased batteries require special handling for recycling and should be separated before smelting.

## ***BATTERY LOG***

Part Number:

___

Serial Number:

___

Aircraft Type:

___

Aircraft Registration Number:

___

| Installation Date | Aircraft Total Time |
|---|---|
| 1st Test | |
| 2nd Test | |
| 3rd Test | |
| 4th Test | |

## *THEORY*

**Simplified lead acid electrochemical reaction**

**Discharge >** **< Charge**

$$PbO_2 + Pb + 2H_2SO_4 \Leftrightarrow 2PbSO_4 + 2H_2O + 2E$$

### Chemical Reactions

A chemical reaction takes place when a battery is being charged or discharged, as represented by the above equation.

On discharge, lead dioxide ($PbO_2$) of the positive electrode and sponge lead (Pb) of the negative electrode are both converted to lead sulfate ($PbSO_4$) freeing two electrons. On charge, the lead sulfate in the positive electrode is converted to lead dioxide ($PbO_2$) (with oxygen evolution on charge) and the lead sulfate in the negative electrode is converted to sponge lead (with hydrogen evolution on charge). The electrolyte, sulfuric acid ($H_2SO_4$), is an active component in the reaction at both electrodes.

**When flooded (vented) batteries** are on charge, the oxygen generated at the positive plates escapes from the cell. Concurrently, at the negative plates, hydrogen is generated from water and escapes from the cell. The overall result is the gassing of the cells and water loss. Therefore, flooded cells require periodic water replenishment.

**When valve regulated Recombinant Gas (RG®) batteries** are on charge, oxygen combines chemically with the lead at the negative plates in the presence of $H_2SO_4$ to form lead sulfate and water. This oxygen recombination suppresses the generation of hydrogen at the negative plates. Overall, there is no water loss during charging. A very small quantity of water may be lost as a result of self discharge reactions, however, such loss is so small that no provision need be made for water replenishment. The battery cells have a pressure relief safety valve that may vent if the battery is overcharged.

**NOTE: DO NOT** remove the pressure relief valves on an RG® battery and **DO NOT** add water or electrolyte. The Recombinant Gas design eliminates the need to replenish water and electrolyte. Removing the pressure relief valve voids the warranty.

## Battery Construction

An aircraft storage battery consists of 6 or 12 lead acid cells connected in series. The open circuit voltage of the 6 cell battery is approximately 12 volts, and the open circuit voltage of the 12 cell battery is approximately 24 volts. Open circuit voltage is the voltage of the battery when it is not connected to a load.

## Cell Construction

The lead acid cell used in aircraft batteries consists of positive plates made of lead dioxide ($PbO_2$); negative plates of pure spongy lead (Pb); and a liquid known as electrolyte, consisting of a mixture of sulfuric acid ($H_2SO_4$) and water ($H_2O$). The sulfuric acid and water are mixed so the solution has a specific gravity (S.G.) of 1.275 to 1.300 in a fully charged battery.

**The specific gravity of a substance is defined as the ratio of the weight of a given volume of the substance to the weight of an equal volume of pure water at 80$^{o}$F / 27$^{o}$C.**

The plates are sandwiched between layers of micro fiber glass mat. Electrolyte is absorbed and held in place by the capillary potential of the fluid and the absorbent glass mat (AGM) fibers.

## Grids and Plates

Each cell of a storage battery has positive and negative plates arranged alternately, insulated from each other by separators. Each plate consists of a framework, called the **grid**, and a lead paste compound called **active material.**

The grid is cast from a lead alloy. The heavy outside frame adds strength to the plate. The small horizontal and vertical wires support the active material. These wires also act as conductors for the current.

The lead paste compound (active material) is applied to the grid in much the same manner as plaster is applied to a lath wall. A different paste formula is used for the positive and negative plates.

In compounding the negative plate paste (active material), a substance is added known as an **expander**. This substance is relatively inert and makes up less than one percent of the mixture. Its purpose is to prevent the loss of porosity of the negative material during the life of the battery. Without the use of an expander, the negative material contracts until it becomes quite dense, thus limiting the surface area available for reaction.

## Plate Groups

Plate groups are made by joining a number of similar plates to a common terminal post by means of a plate strap. The capacity of a battery is determined by the number and size of plates in a group. Each plate is made with a lug at the top which is fused to the strap. A positive group consists of a number of positive plates connected to a plate strap and a negative group consists of a number of negative plates connected in the same manner. The two groups meshed together with separators between the positive and negative plates constitute a **cell element**.

## Separators

The separators used in aircraft batteries are made of micro-porous polypropylene material. Their purpose is to keep the plates separated and thus prevent an internal short circuit. In the RG® Series batteries a second separator made from micro fiber absorbent glass mat (AGM) is also used.

The separator material must be extremely porous so that it will offer a minimum of resistance to the ions passing through them. The material must also resist chemical attack from the electrolyte.

The AGM, by design, is approximately 92% saturated with electrolyte. The remainder is filled with gas. This void space provides the channels by which oxygen travels from the positive to the negative plate during charging. The freshly generated gases, which are in their atomic state and very reactive, recombine rapidly and safely.

The recombination passivates the negative slightly, reducing electrolysis and ultimately eliminating the need to add water. Because of the compressed construction, the RG® batteries have a much lower internal resistance and thus provide greater starting power and faster recharging, particularly at cold temperatures, than comparable flooded batteries. Additionally, the AGM provides a much higher degree of support against shock and vibration than in the older flooded (vented) batteries. The RG® batteries provide electrical performance comparable to nickel cadmium aircraft batteries without the requirement of a temperature or current monitoring system.

## Cell Containers

When the cell elements are assembled, they are placed in the **cell container** which is made of plastic. Usually cell containers are made up in a monobloc with as many compartments as there are cells in the battery. The plastic used is selected for its resistance to sulfuric acid, low permeability and impact strength.

**Cell Covers, Vent Valves and Vent Caps**

The assembled cell has a cover made of material similar to that of the cell container. The cell or monobloc cover has holes through which the terminal posts extend and a retention hole for vent cap or valve attachment. When the cover is placed on the cell(s), it is sealed to the container or case with a special sealing compound to prevent leakage and loss of electrolyte.

## *PRECAUTIONS*

There are several precautions which must be observed when handling storage batteries and especially when charging.

When a flooded (vented) storage battery is being charged, it generates a substantial amount of hydrogen and oxygen. The vent caps should be left in place and no open flames, sparks or other means of ignition should be allowed in the vicinity.

Recombinant Gas (RG®) storage batteries generally do not vent when being charged UNLESS they are being overcharged. Always turn off the power before connecting or disconnecting a storage battery from a charging source.

The electrolyte contains sulfuric acid. Sulfuric acid is very corrosive. Avoid contact with flesh, cloth or wood. Be very careful not to spill the electrolyte. If it should be spilled, immediately rinse with water and neutralize it with a solution of water and bicarbonate soda or a mild ammonia and water solution.

There should be adequate ventilation of the area where storage batteries are being charged in order to dissipate the gasses and acid fumes.

**Separate facilities** for storing and/or servicing flooded electrolyte lead acid and nickel cadmium batteries must be maintained. Introduction of acid electrolyte into alkaline electrolyte will cause permanent damage to vented (flooded electrolyte) nickel-cadmium batteries and vice versa. However, batteries that are sealed can be charged and capacity checked in the same area. Because the electrolyte in a valve regulated lead acid battery is absorbed in the separators and porous plates, it **cannot contaminate a nickel cadmium battery even when they are serviced in the same area.**

**Caution: Aircraft are certified with batteries that have reserve or essential capacity for emergency operation. Never "jump start" an aircraft that has a "dead" or discharged battery. It takes approximately three hours to fully recharge a discharged battery with the aircraft generating system.**

**NOTE: With flooded (vented) batteries, unless the battery electrolyte was accidentally spilled, you should only add demineralized water in normal service. Water consumption varies with the operating temperature of the battery and the charging voltage.**

1) The electrolyte level should be checked at the end of charge and filled to the bottom of the level indicator with water when charging flooded (vented) batteries. Do not allow the reserve electrolyte level to go below the top of the plates or the battery performance and life will be reduced.

2) The capacity of flooded (vented) and Recombinant Gas (RG®) batteries should be checked annually or as often as the Regional Airworthiness Authority Regulations require.

3) Discharged batteries exposed to cold temperatures are subject to plate and separator damage due to freezing. To prevent freezing damage to a lead acid battery, maintain the batteries in a charge state.

### *ACTIVATION OF DRY CHARGED BATTERIES*

**Caution:**

1) **Do not remove the sealing tape on the cell vents until you are ready to fill the battery with electrolyte. Aircraft Batteries require a pure diluted sulfuric acid electrolyte of 1.285 specific gravity at 80°F or 27°C. Check the specific gravity of the electrolyte before filling the cells of the battery to be sure it is the correct type and specific gravity.**

2) **Use a clean hydrometer to determine the specific gravity of the battery electrolyte.**

3) **If it should become necessary to dilute concentrated sulfuric acid to a lower specific gravity, ALWAYS POUR THE ACID INTO THE WATER. NEVER POUR WATER INTO ACID, a dangerous "spattering" of the liquid will result caused by the extreme heat which is generated when strong acid is mixed with water. Stir liquid continuously while acid is being added.**

**4) When working with acid, always wear a face shield and protective clothing. Sulfuric acid can destroy clothing and burn skin. If electrolyte is spilled or splashed on clothing or on the body, it must be neutralized immediately with a solution of baking soda and water and rinsed with clean water.**

**5) If electrolyte is splashed into the eyes, force the eyes open and flood with cool clean water for approximately five minutes. Call a physician and get medical attention immediately.**

**6) If electrolyte is taken internally, drink large quantities of water or milk. Do not induce vomiting. Call a physician immediately.**

**7) Do not place battery acid within the reach of children.**

**CAUTION: Hydrogen and oxygen gases are produced during normal battery operation. Explosive gases may continue to be present in and around the battery for several hours after it has been charged. Keep sparks, flames, burning cigarettes and other sources of ignition away at all times.**

## *MIXING OF ELECTROLYTE*

Electrolyte of a given specific gravity can be purchased; however, it is sometimes more convenient to mix it at the shop or hangar. The following table gives the proper amount of demineralized water to be mixed with a given amount of acid to obtain the desired specific gravity.

The container in which electrolyte is mixed should be made of glass, glazed earthenware or other material which will not be attacked by the acid.

| Specific Gravity Desired | Add 1 gallon 1.400 Acid to: | Add 1 gallon 1.835 Acid to: |
|---|---|---|
| 1.275 | 1/2 gallon demineralized water | 2-3/4 gallon demineralized water |
| 1.300 | 1/3 gallon demineralized water | 2-1/2 gallon demineralized water |

**CAUTION:** When mixing acid with water, always pour the acid into the water. Never pour water into the acid. The heat generated may cause the acid to spatter on the operator. Severe burns may result.

After the electrolyte is mixed, it may be tested for specific gravity. If the specific gravity is not as desired, it can easily be adjusted by the addition of acid or water. Be sure to correct the specific gravity reading for temperature. (See temperature correction of S.G. reading.)

When purchasing acid or electrolyte for battery use, “commercial” grade acid should not be used. Use “battery” grade sulfuric acid which is free of impurities that may contaminate a battery. It is not as expensive as the chemically pure grade, commonly called “Reagent Grade.”

## *BATTERY TESTING*

### Hydrometer Test

The most common instrument used for the testing of flooded electrolyte batteries is the **hydrometer**. Concorde recommends the FR-1 Aircraft Battery Hydrometer. The specific gravity of the electrolyte in a battery cell is a good index of the state of charge in the cell. This is due to the fact that as the battery is discharged, the acid in the electrolyte is used in the chemical reaction. This means the acid has broken down, part of it combining with the lead of the plates to form lead sulfate and part of it combining with oxygen to form water. Since the weight of the acid is much greater than that of the water, the reduction of acid and the increase of water will cause the specific gravity of the electrolyte to decrease.

A hydrometer is used to determine the specific gravity of the electrolyte and it generally consists of a glass barrel with a rubber hose on one end and a soft rubber bulb on the other. Inside the glass barrel is a glass float with calibrated graduations. The bulb is squeezed and the rubber hose is inserted into the electrolyte in the battery cell. When the bulb is released electrolyte is drawn into the glass barrel. At eye level and when the float has stabilized, the specific gravity is read at the point on the calibrated float where the surface of the electrolyte crosses the float markings. The specific gravity range is usually 1.100 to 1.300. After the reading is taken, the rubber bulb is squeezed to release the electrolyte back into the battery cell.

It is important to make sure the float is not sticking to the side of the glass barrel and that the electrolyte can be seen between the bottom of the float and the bottom of the glass barrel. If irregular readings are obtained, examine the glass float closely for hairline cracks. It is a good idea to have more than one hydrometer on hand so that one can be checked against the other. The hydrometer must be kept clean. Accumulation of dry acid can cause the float to read inaccurately. The hydrometer should be taken apart and washed occasionally.

A specific gravity reading from 1.275 to 1.300 usually indicates a fully charged cell. If the reading is from 1.200 to 1.240 the charge is considered low. This does not mean that the cell is nearly discharged, but it indicates that it may not be able to furnish power sufficient for heavy loads such as starting engines. A reading of 1.260 in a battery indicates a state of charge sufficient for normal operation, even though it is not fully charged.

**It must be pointed out that the specific gravity reading is not always an indication of the state of charge in a cell.** If the electrolyte is removed from a discharged cell and replaced with an electrolyte of a high specific gravity, the cell will still be in a discharged condition even though the hydrometer test shows a full charge reading.

Normally, electrolyte should never be added or removed from a cell. The addition of water is necessary periodically to replace the amount lost through electrolytic action and evaporation. Acid should never be added unless electrolyte has been lost by spillage because acid does not evaporate. When it is necessary to add acid, the battery should be fully charged, on charge and gassing freely. Then, by means of a rubber syringe or hydrometer, the electrolyte is drawn off and replaced with electrolyte having a specific gravity of 1.285. The charge should be continued for one hour before making another test.

### *TEMPERATURE CORRECTION OF SPECIFIC GRAVITY READING*

**Points to be subtracted or added to specific gravity reading**

| Electrolyte Temperature ºC | Electrolyte Temperature ºF | Points to be subtracted or added to specific gravity readings |
|---|---|---|
| 60 | 140 | +24 |
| 55 | 130 | +20 |
| 49 | 120 | +16 |
| 43 | 110 | +12 |
| 38 | 100 | +8 |
| 33 | 90 | +4 |
| 27 | 80 | 0 |
| 23 | 70 | -4 |
| 15 | 60 | -8 |

| | | |
|---|---|---|
| 10 | 50 | -12 |
| 5 | 40 | -16 |
| -2 | 30 | -20 |
| -7 | 20 | -24 |
| -13 | 10 | -28 |
| -18 | 0 | -32 |
| -23 | -10 | -36 |
| -28 | -20 | -40 |
| -35 | -30 | -44 |

Batteries are considered fully charged when the temperature corrected specific gravity reading is 1.285 +/- 0.005. A 1/3 discharged battery reads about 1.240 and a 2/3 discharged battery will show a specific gravity reading of about 1.200 when tested with a hydrometer. However, to determine precise specific gravity readings, temperature corrections shown in the table above should be applied.

The corrections in the table should be added or subtracted from the hydrometer reading. For example, if the temperature of the electrolyte is 10 degrees Fahrenheit, and the hydrometer reading is 1.250, the corrected reading will be 1.250 minus .028 equals 1.222. Notice that the correction points are in thousandths.

## *CHARGING METHODS*

**NOTE: FOR SPECIFIC CHARGING INSTRUCTIONS** See Concorde Battery Corporation's *Instructions for Continued Air Worthiness Maintenance Manual Supplement for Concorde Flooded Lead Acid Main Battery* (Drawing: 5-0144); *Instructions for Continued Air Worthiness Maintenance Manual Supplement for Concorde Valve Regulated Lead Acid Main Battery* (Drawing: 5-0142); *Instructions for Continued Air Worthiness Maintenance Manual Supplement for Concorde Valve Regulated Lead Acid Emergency Battery Packs* (Drawing: 5-0143). See our website: www.concordebattery.com for the latest revision.

Storage batteries are charged by passing a direct current through them in a direction opposite to that of the discharge current. The power supply must be connected to the battery, positive to positive and negative to negative. Various sources of direct current may be used, but the most commonly used devices are either rectifiers or direct current generators. The manner in which batteries are connected to the power source will vary.

This is usually determined by the type and the voltage of the batteries being charged. When batteries of different voltages must be charged by the same power supply, they are usually charged by the constant current method (CI). Another method used is the constant potential (CP) (voltage) method. This system is usually used on aircraft, where an engine driven generator is continually charging the battery according to its requirements.

Battery charging methods may also be classified as “manually cycled” and “system governed” methods. Usually, where batteries are charged in the hanger or shop, the manually cycled method is employed. This means simply that the voltage or current is controlled by an operator according to the requirements of the batteries being charged. In the system governed method, the voltage of the power supply is automatically controlled by a carefully adjusted voltage regulator.

**Constant Voltage Charging (CP)**

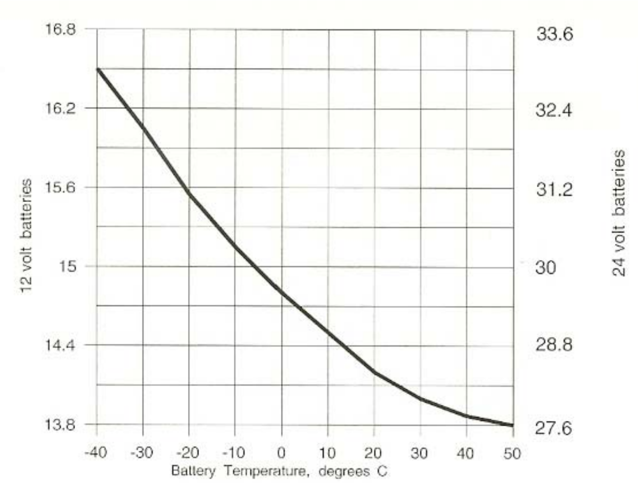
The battery charging system in an airplane is of the constant voltage type. An engine driven generator, capable of supplying the required voltage, is connected through the aircraft electrical system directly to the battery. A battery switch is incorporated in the system so that the battery may be disconnected when the airplane is not in operation. The voltage of the generator is accurately controlled by means of a voltage regulator connected in the field circuit of the generator.

For a 12 volt system, the voltage of the generator is adjusted to approximately 14.25. On 24 volt systems, the adjustment should be between 28 and 28.5 volts. When these conditions exist, the initial charging current through the battery will be high. As the state of charge increases the battery voltage also increases, causing the current to taper down.

When the battery is fully charged, its voltage will be almost equal to the generator voltage, and very little current will flow into the battery. When the charging current is low, the battery may remain connected to the generator without damage.

The following chart shows voltage regulator settings for 12 volt or 24 volt systems and are intended to meet average conditions. However, when the airplane is to be used in hot or cold climates, the voltage settings in the table are recommended:

| Battery Temperatures | Generator Voltage | |
|---|---|---|
| | 24 V | 12 V |
| 90º F. or higher | 27.5 | 13.75 |
| 50º to 90º F. | 28 to 28.5 | 14.0 - 14.2 |
| 50º F. or lower | 29.5 | 14.75 |




**Recommended Charging Voltage**

Recommendations above are based on the fact that when there is a variation of battery temperature there is a variation of the final or full charge voltage.

At extremely low battery temperatures a setting of 28.5 volts does not supply enough current to charge a battery adequately. At battery temperatures in excess of $90^0$ the current input at 28.5 volts tends to over charge the battery.

When using a constant voltage system in a battery shop, a voltage regulator that automatically maintains a constant voltage is incorporated in the system. A higher capacity battery (e.g. 42 Ah) has a lower resistance than a lower capacity battery (e.g. 33 Ah). Hence a high capacity battery will draw a higher charging current than a low capacity battery when both are in the same state of charge and when the charging voltages are equal.

## Constant Current Charging (CI)

Constant current charging is the most convenient for charging batteries outside the airplane because several batteries of varying voltages may be charged at once on the same system. A constant current system usually consists of a rectifier to change the normal alternating current supply to direct current. A transformer is used to reduce the available 110 volt or 220 volt alternating current supply to the desired level before it is passed through the rectifier.

If a constant current system is used, multiple batteries may be connected in series, provided that the charging current is kept at such a level that the battery does not overheat or gas excessively.

**Conditioning After Deep Discharge, see applicable Instructions for Continued Airworthiness (ICA)** (See our website: www.concordebattery.com for the latest revision).

## *CAPACITY TEST*

For test procedures and instructions, see Concorde's Instructions for Continued Airworthiness (ICA) (available on our website: www.concordebattery.com).

Batteries that have a capacity greater than 80% of the C1 rated capacity may be considered airworthy. To insure a safety margin, Concorde recommends that batteries have an actual capacity of greater than 85% of the C1 rated capacity for installation in an aircraft.

Capacity testing devices for aircraft storage batteries have been developed and these give an accurate indication of the condition of a battery. A **capacity tester** generally incorporates load resistance, a voltmeter and a time clock. Some models show the percentage of capacity or ampere hours. A fully charged battery is connected to a measured load until the voltage, as indicated on the voltmeter, drops to a predetermined figure. At this time the reading on the clock is noted. The reading gives the capacity of the battery tested.

After this test, the battery should be recharged by either the constant current or constant voltage method described in the applicable ICA. For discharging or charging batteries, it is best to have a disconnect switch on the discharge apparatus or on the charging panel. The closing and opening of the battery circuit by use of spring clips on the battery terminals should be avoided as the resulting arc may cause an explosion of the battery gasses.

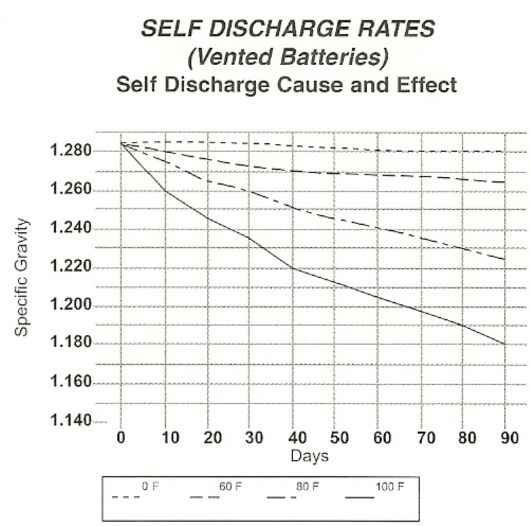
The discharge voltage of a healthy battery does not decrease with age although it will be found that an older battery may not have as high of an open circuit voltage when fully charged.

***BATTERY STATE OF CHARGE (S.O.C.)***

| **S.O.C.** | **12 volt O.C.V.** | **24 volt O.C.V.** | **S.G.** |
|---|---|---|---|
| 100% | 12.9 | 25.8 | 1.300 |
| 75% | 12.7 | 25.4 | 1.270 |
| 50% | 12.4 | 24.8 | 1.220 |
| 25% | 12.0 | 24.0 | 1.140 |
| 0% | 11.7 | 23.4 | 1.090 |

***BATTERY STATE OF HEALTH***

A battery's state of health must be determined by verifying its ability to provide sufficient stored energy for essential power requirements. The amount of stored energy (battery capacity) required to start a reciprocating engine is generally less than 3%, while a turbine engine start requires approximately 10% of the rated capacity. Good starting performance is not necessarily a safe indication of the battery's state of health. An airworthy battery must be able to provide essential power in the event of a failure of the generating system. Therefore, a periodic capacity check of the battery at the C1 rate (one hour) is recommended.




| TITLE<br>AIRCRAFT BATTERY OWNER/ OPERATOR MANUAL | | | | DWG. NO.<br>5-0164 | REVISION<br>B |
|---|---|---|---|---|---|
| CAGE CODE<br>63017 | DRAWN<br>JBT 10/08/04 | CHECKED<br>AT 10/14/04 | APPROVED<br>JBT 10/14/04 | ISSUED<br>AT 09/09/05 | SHEET<br>18 of 27 |

100 $^{o}$ F (37.8 $^{o}$ C) - 0.0025 Specific Gravity per day
80 $^{o}$ F (26.7 $^{o}$ C) - 0.0010 Specific Gravity per day
50 $^{o}$ F (10 $^{o}$ C) - 0.0003 Specific Gravity per day

After the battery has been fully charged, the above values are valid for approximately 10 days. **Flooded (vented) batteries have a higher rate of self discharge than the Valve Regulated Batteries (VRB) (RG® Series).** To minimize the extent of self discharge, store charged batteries in a cool place.

## *COLD WEATHER OPERATION*

Temperature is a vital factor in the operation and life of a storage battery. Chemical reactions take place more rapidly with heat than with cold. For this reason, a battery will give much better performance in temperate or tropical climates than in cold climates. On the other hand, the battery will deteriorate faster in warm climates. In some cases, a lower specific gravity electrolyte is specified for warm climate operation in order to add to the life of the battery because chemical reactions are more rapid in warmer climates.

In cold climates, the state of charge in a storage battery should be kept at a maximum. A fully charged battery will not freeze even under the most severe weather conditions, but a discharged battery will freeze very easily. When adding water to a battery in extremely cold weather, the battery must be charged at once. If this is not done, the water will not mix with the acid and will freeze.

The following table gives the freezing points of electrolyte for various states of charge. These are the approximate points at which ice crystals start to form. The electrolyte does not freeze solid until a lower temperature is reached. Solid freezing of electrolyte in a discharged battery will damage the plates and may rupture the container.

| Specific Gravity | Freezing Point | |
|---|---|---|
| | ºC | ºF |
| 1.300 | - 70 | - 95 |
| 1.275 | - 62 | - 80 |
| 1.250 | - 52 | - 62 |
| 1.225 | - 37 | - 35 |
| 1.200 | - 26 | - 16 |
| 1.175 | - 20 | - 4 |

| | | |
|---|---|---|
| 1.150 | - 15 | + 5 |
| 1.125 | - 10 | + 13 |
| 1.100 | - 7 | + 19 |

**Capacity Loss Due to Low Temperatures**

Operating a storage battery in cold weather is equivalent to using a battery of lower capacity. For example, a fully charged battery at 80º F may be capable of starting an engine twenty times. At 0º F the same battery may start the engine only three times.

Low temperature greatly increases the time necessary for charging a battery. A battery which could be recharged in an hour at 80º F while flying may require approximately five hours for charging when the temperature is 0º F

During cold weather, keep batteries fully charged. Make every effort to conserve battery power.

## VENTILATING SYSTEMS

Modern airplanes are equipped with battery ventilating systems. The ventilating system provides for the removal of gasses and acid fumes from the battery in order to reduce fire hazard and to eliminate damage to airframe parts. Air is carried from a scoop outside the airplane through a vent tube to the interior of the battery case. After passing over the top of the battery, air, battery gasses and acid fumes are carried through another tube to the battery sump.

This sump is a glass or plastic jar of at least one pint capacity. In the jar is a felt pad about 1 inch thick saturated with a 5% solution of bicarbonate of soda and water. The tube carrying fumes to the sump extends into the jar to within about 1/4 inch of the felt pad.

An overboard discharge tube leads from the top of the sump jar to a point outside the airplane. The outlet for this tube is designed so there is negative pressure on the tube whenever the airplane is in flight. This helps to insure a continuous flow of air across the top of the battery, through the sump and outside the airplane. The acid fumes going into the sump are neutralized by the action of the soda solution, thus preventing corrosion of the aircraft's metal skin or damage to a fabric surface.

## *INSPECTION AND SERVICE*

See applicable ICA.

## *STORAGE*

See applicable ICA.

## *GLOSSARY*

**Active material -** Electrode material which produces electricity during its chemical conversion.

**AGM -** Absorbent glass mat.

**Ampere -** Unit of electrical current.

**Ampere hour (Ah) -** The capacity of a storage battery is measured in **ampere hours**. One ampere hour is defined as a current flow of one ampere for a period of one hour. Five ampere hours means a current flow of one ampere for five hours, a current flow of 2-1/2 amperes for 2 hours, or any multiple of current and time that will give multiples of five. This relationship can be expressed as follows: Capacity (in ampere hours) = I X T, when I is the current (in amperes) and T is the time (in hours). The capacity of a storage battery is usually based on a given discharge rate, since the capacity will vary with the rate of discharge. The capacity of an aircraft battery is generally based on **1hour discharge rate (C1)**. A 17 ampere hour battery will supply a current of approximately 17 amperes for a period of 1 hour. A 34 ampere hour battery will deliver twice that amount of current for the same period of time. If a very heavy load is applied to the battery, it may become discharged in a few minutes.

**Battery -** A combination of two or more chemical cells electrically connected together to produce electric energy. Common usage permits this designation to be applied also to a single cell used independently.

**Boost charge -** A charge applied to a battery which is already near a state of full charge. Usually a charge of short duration.

**C1 rate -** The one hour discharge or current rate in amperes that is numerically equal to rated capacity of a cell or battery in ampere hours.

**Capacity -** The quantity of electricity delivered by a battery under specified conditions, usually expressed in ampere hours.

**Capacity, rated -** See **nominal capacity**.

**Cell -** An electrochemical device composed of positive and negative plates, separator and electrolyte which is capable of storing electrical energy.

**Cell reversal -** Reversing of polarity within a cell in a multicell battery due to over discharge.

**Charge -** The conversion of electrical energy from an external source into chemical energy within a cell or battery.

**Charge rate -** The rate at which current is applied to a secondary cell or battery to restore its capacity.

**Charge retention -** The tendency of a charged cell or battery to resist self discharge.

**Concavo/concave -** RG® batteries have one way cell vent valves designed to relieve excess positive internal pressure. Occasionally, when the atmospheric pressure is greater than the internal pressure of the battery (caused by a rapid decrease in altitude), the battery case may become temporarily concave.

**Constant potential (CP) charge -** Charging technique where the output voltage of the charge source is held constant and the current is limited only by the resistance of the battery.

**Constant current (CI) charge-** Charging technique where the output current of the charge source is held constant and the voltage is not regulated.

**Counter EMF -** Voltage of a cell or battery opposing the voltage of the charging source. When the electromotive force (EMF) of the source is greater than the EMF of the battery, the current flows in the reverse direction.

**Current -** The rate of flow of electricity. The movement of electrons along a conductor. It is comparable to the flow of a stream of water. The unit of measurement is an ampere.

**Cut off voltage -** Battery voltage reached at the termination of a discharge. Also known as end point voltage (EPV or VEP).

**Deep discharge -** Withdrawal of 50% or more of the rated capacity of a cell or battery.

**Deionized water -** Water which has been freed of ions by treatment with ion exchange resins.

**Depth of discharge -** The portion of the nominal capacity from a cell or battery taken out during each discharge cycle, expressed in a percentage. Shallow depth of discharge is considered as 10% or less, deep depth of discharge is considered as 50% or more.

**Discharge -** The conversion of the chemical energy of a cell or battery into electrical energy and withdrawal of the electrical energy into a load.

**Discharge rate -** The rate of current flow from a cell or battery.

**Distilled water -** Water which has been freed of minerals or metallic impurities by a process of vaporization and subsequent condensation. Deionized and distilled are not the same.

**Dry charge -** Process by which the electrodes are formed and assembled in a charged state without electrolyte. The cell or battery is activated when the electrolyte is added.

**Effective internal resistance (Re) -** The apparent opposition to current within a battery that manifests itself as a drop in battery voltage proportional to the discharge current. Its value is dependent upon battery design, state of charge, temperature and age.
**Electrolyte -** In a lead acid battery, the electrolyte is sulfuric acid diluted with water. It is a conductor and is also a supplier of hydrogen and sulfate ions for the reaction.

**Electromotive force (EMF) -** Potential causing electricity to flow in a closed circuit.

**Electron -** That part of an atom having a negative charge.

**End of discharge voltage -** The voltage of the battery at the termination of a discharge test but before the discharge is stopped. See cut off voltage and End point voltage (EPV).

**End of life -** The stage at which the battery or cell meets specific failure criteria.

**End point voltage (EPV) -** Cell or battery voltage at which point the rated discharge capacity had been delivered at a specified rate of discharge. Also used to specify the cell or battery voltage below which the connected equipment will not operate or below which operation is not recommended. Sometimes called cutoff voltage or voltage end point.

**Entrainment -** The process whereby gasses generated in the cell carry electrolyte through the vent cap.

**Fast charging -** Rapid return of energy to a battery at the C rate or more.

**Float charge -** A method of maintaining a cell or battery in a charged condition by continuous, long term constant voltage charging at a level sufficient to balance self discharge.

**Flooded cell -** Concorde's cell design with a removable vent cap that allows the user to service the cell (e.g. check electrolyte levels, specific gravity, etc.). Also called a **vented cell**.

**Gassing -** The evolution of gas from one or more of the electrodes in a cell. Gassing commonly results from local action (self discharge) or from the electrolysis of water in the electrolyte during charging.

**Ground -** In aircraft use, the result of attaching one battery cable to the body or airframe which is used as a path for completing a circuit in lieu of a direct wire from a component.

**Hydrometer -** A float type instrument used to determine the state of charge of a battery by measuring the specific gravity of the electrolyte (i.e. the amount of sulfuric acid in the electrolyte).

**Instructions for Continued Airworthiness –** ICA

**Internal impedance -** The opposition to the flow of an alternating current at a particular frequency in a cell or battery at a specified state of charge and temperature.

**Internal resistance -** The opposition or resistance to the flow of a direct electric current within a cell or battery; the sum of the ionic and electronic resistance of the cell components. Its value may vary with the current, state of charge, age and temperature. With an extremely heavy load, such as an engine starter, the cell voltage may drop to approximately 1.6 volts. This voltage drop is due to the internal resistance of the cell. A cell that is partly discharged has a higher internal resistance than a fully charged cell, hence it will have a greater voltage drop under the same load. This internal resistance is due to the accumulation of lead sulfate on the plates. The lead sulfate reduces the amount of active material exposed to the electrolyte, hence it deters the chemical action and interferes with the current flow.

**Ion -** Molecule or group of atoms, positively or negatively charged, which transports electricity through the electrolyte.

**Joules -** Unit of energy, equal to a watt second (a newton meter).

**Lead acid -** Term used in conjunction with a cell or battery that utilizes lead and lead dioxide as the active plate materials in a diluted electrolyte solution of sulfuric acid and water. Nominal cell voltage about 2.1 volts.

**Lead dioxide -** A higher oxide of lead present in charge positive plates and frequently referred to as lead peroxide.

**Lead sulfate -** A lead salt formed by the action of sulfuric acid on lead oxide during paste mixing and formation. It is also formed electrochemically when a battery is discharged.

**Load tester -** An instrument which measures the battery voltage with an electrical load on the battery to determine its overall condition and its ability to perform under engine starting conditions or essential power requirements.

**Nominal capacity -** A designation by the battery manufacturer which helps identify a particular cell model and also provides an approximation of capacity; usually expressed in ampere hours at a given discharge current.

**Nominal voltage -** Voltage of a fully charged cell or battery when delivering rated capacity at a specified discharge rate.

**Open circuit voltage (O.C.V.) -** The voltage of a battery when it is not delivering or receiving power.

**Overcharge -** The forcing of current through a cell after all the active material has been converted to the charged state. In other words, charging continued after 100% state of charge is achieved. The result will be the decomposition of water in the electrolyte into hydrogen and oxygen gas.

**Oxygen recombination -** The process by which oxygen generated at the positive plate during charge reacts with the pure lead material of the negative plate and in the presence of sulfuric acid reforms water.

**Parallel connection -** A circuit in which battery poles of like polarity are connected to a common conductor; ie: higher capacity while voltage remains the same.
**Polarity -** The electrical term used to denote the voltage relationship to a reference potential. (+ or -)

**Power -** Rate at which energy is released or consumed (expressed in watts).

**Rated capacity -** The number of Ahs a battery can deliver under specific conditions (rate of discharge, end voltage, temperature).

**Re -** See **Effective internal resistance**.

**Recombination -** State in which the hydrogen and oxygen gases normally formed within the battery cell during charging are recombined to form water.

**Resealable -** In a cell, pertains to a safety vent valve which is capable of closing after each pressure release, in contrast to the nonresealable vent cap.

**Sealed cell -** Cells that are free from routine maintenance and cannot be serviced by the user. Concorde batteries can be installed and operated without regard to position of the battery.

**Self discharge -** The decrease in the state of charge of a cell or a battery, over a period of time, due to internal electro chemical losses, effected by environmental temperatures.

**Separator -** A porous, insulating material placed between plates of opposite polarities to prevent internal short circuits.

**Specific gravity (S.G.) -** The weight of the electrolyte is compared to the weight of an equal volume of pure water, used to measure the strength or percentage of sulfuric acid in the electrolyte.

**Starved cell -** A cell containing little or no free fluid electrolyte solution. This enables gases to reach electrode surfaces readily, and permits relative high rates of gas recombination.

**State of charge (S.O.C.) -** The available ampere hours in a battery at any given time. State of charge is determined by the amount of sulfuric acid remaining in the electrolyte (specific gravity) at the time of testing or by the stabilized open circuit voltage (O.C.V.).

**Sulfation -** In its common usage, the term refers to the formation of lead sulfate with physical properties that are extremely difficult, if not impossible, to reconvert it to active material.

**Swelling** - RG® battery cases swell or bulge when the cell vent valves maintain an internal pressure that is greater than the outer (atmospheric) pressure.

**Trickle charge -** A continuous, low rate charge, the rate being just about sufficient to compensate for self discharge losses.

**Vent valve -** A normally sealed mechanism which allows the controlled escape of gases from within a cell.

**Vent cap -** The plug on top of a cell. It can be removed to allow for electrolyte level adjustment on flooded (vented) batteries.

**Vented cell** - see **Flooded cell**.

**Venting -** A release of gas either controlled (through a vent) or accidental.

**Volt -** Unit of electromotive force, voltage or potential. The volt is the voltage between two points of a conductor carrying a constant current of one ampere, when the power dissipated between these points is one watt.


**CONCORDE BATTERY CORPORATION**
2009 San Bernardino Road
West Covina, CA 91790
Tel. 626-813-1234
Fax. 626-813-1235
Email: customer-service@concordebattery.com
www.concordebattery.com


AS 9100 REV. B:2004 and ISO 9001: 2000