TELEDYNE BATTERY PRODUCTS

COMPONENT MAINTENANCE MANUAL

LT Valve-Regulated Lead-Acid Batteries

Part Numbers Applicable to this CMM are:

7025-20	7243-16T	7641-20
7025-24	7246-20	7638-36
7035-28	7246-20AT	7638-44
7035-34	7407-28	7638-44T
7242-14	7639-25	7638-44ST
7242-16	7639-27	7638-48P
7243-14	7639-30LT	7638-53
7243-16	7639-34	

See Scope, Section 2 for any limitations on applicability

Proposition 65 Warning

BATTERY POSTS, TERMINALS AND RELATED ACCESSORIES CONTAIN LEAD AND LEAD COMPOUNDS, CHEMICALS KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER AND REPRODUCTIVE HARM.

WARNING

THE SAFETY INSTRUCTIONS AND PRECAUTIONS POSTED AND NOTED IN VARIOUS SECTIONS OF THIS MANUAL MUST BE STRICTLY FOLLOWED.

WARNING

ALWAYS WEAR SAFETY GLASSES AND ACID-RESISTANT GLOVES WHENEVER HANDLING BATTERIES. ELECTROLYTE CONTAINS SULFURIC ACID, WHICH CAN PERMANENTLY DAMAGE EYES AND CAUSE SEVERE BURNS AND DAMAGE TO EXPOSED SKIN.

FOR LIMITATIONS, PROCEDURES AND PERFORMANCE INFORMATION NOT CONTAINED IN THIS SUPPLEMENT CONSULT THE BASIC PILOTS OPERATING HANDBOOK, AIRPLANE FLIGHT MANUAL, AND THE SPECIFIC STC OR THE BATTERY CONTINUOUS AIRWORTHINESS INSTRUCTIONS FOR THE APPLICATION.

THIS SERVICE MANUAL SHOULD NOT BE CONSTRUED AS THE FINAL AUTHORITY IN MAINTAINING YOUR SPECIFIC BATTERY, PLEASE CONSULT WITH TELEDYNE TECHNICAL SUPPORT OR VISIT OUR WEBPAGE FOR THE LATEST/FURTHER INFORMATION.

CONTENTS

REVISIONS

Revision	Description of Change	Approved By	Date
NC	New document	JMR	10-27-07
A	Revised charging instructions, title	JMR	12-10-09
B	Revised charging instructions – added Initial Charge; added new spec sheets	JMR	09-22-10
C	Added table for Constant Current Charging; troubleshooting guide; revised SOC vs Voltage chart; Battery installation; Float charging recommendation and Reconditioning procedure	JMR	3-31-13
D	Added 7035 and 7243 batteries	JMR	5-6-13
E	Revised all specifications	JMR	12-5-13
F	Revised references	JMR	3-17-14
G	Added 7025	JMR	9-26-14
H	Added 7243-14, 7638-44T	JMR	6-1-16
J	Removed 7638-34, 7638-36, 7639-30LT and 7638-48P; revised content	JMR	6-8-16
K	Revised Logo and specifications to include all LT models and clarified storage instructions	JMR	11-20-18

SCOPE

This manual provides Maintenance Procedures for all Gill branded 7000 Series LT Valve-Regulated Lead-Acid (LT VRLA) Aircraft Batteries manufactured under FAA Parts Manufacturer Approval number PQ1006NM for type-certificated aircraft.

Some models listed on the cover also have separate CMM's available from Teledyne, which are dedicated to the specific model number for a specific OEM application(s). In the event of a conflict between the latest revision of this document and the latest revision of any separate specific OEM Model Maintenance Manual the specific separate OEM Maintenance Manual takes precedence.

This manual has been written for the purpose of guidance only and if printed may be out of date; consult our web page and Teledyne Battery Products (TBP) Technical Support for the latest CMM and further information.

This CMM is the primary source of all maintenance requirements for the 7000 Series batteries.

The latest list of our PMA's and CMM's can be obtained on our website at: www.gillbatteries.com or by calling our Customer Support at (800) 456 0070.

VALVE-REGULATED LEAD-ACID BATTERIES

3.1 DESCRIPTION

3.1.1. The 7000 series LT valve-regulated lead-acid (LT-VRLA) batteries are designed with optimum electrodes to provide the best possible performance characteristics for valve-regulated lead-acid batteries. These LT-VRLA batteries contain electrolyte absorbed in glass-mat (AGM) separators, with no free electrolyte and are sometimes referred to as "sealed" or "recombinant-gas" batteries.

WARNING

ALL VRLA batteries contain sulfuric acid, which is highly corrosive and which can cause serious physical injury if it comes in contact with skin or if inhaled. It can also cause serious eye injury or blindness if it comes into contact with the eyes.

Caution must be exercised to avoid damage to the exterior case, which could allow the contents to escape or come in physical contact with external materials or personnel.

If a battery case is found to be damaged, handle the battery with care and avoid contact with the skin. Inspect all areas adjacent to the battery for evidence of corrosion.

3.1.2. TBP valve-regulated lead-acid batteries have vent caps (with valves enclosed) that are sealed in place and cannot be accessed for maintenance. At no time must these vent caps be removed.

WARNING

During normal operation, the batteries will vent very small amounts of gases that must be vented away from the battery and aircraft. The venting mechanisms consist of nozzles (in the battery cover) and vent tubes that are designed to exhaust the battery compartment. Ensure that the vent tubes are not restricted or disabled in any way.

3.1.3. The electrolyte is contained in an absorptive glass-mat (AGM) separator that retains and immobilizes the electrolyte. These batteries can be operated in any orientation without spilling electrolyte.

3.1.4. The battery consists of six or twelve cells connected in series internally, for 12V or 24V batteries respectively. These cells are not replaceable.

3.1.5. Each cell is constructed of positive and negative electrodes electrically isolated by AGM separators.

3.2 SPECIFICATION DEFINITION

3.2.1 TBP battery ratings are defined by a series of specifications:

3.2.1.1 **The One-Hour Rate**
This is the rate of discharge (current, A) a battery can endure for one hour with the battery voltage at or above 1.67 volts per cell, which is 10V for a 12V battery or 20V for a 24V battery.

The One-Hour Capacity, measured in Ampere Hours or Ah, is the product of the discharge rate (A) and time (in hours) to the specified end voltage.

3.2.1.2 **The Emergency Rate**
This is the rate of discharge (current, A) a battery can endure for thirty minutes with the battery voltage at or above 1.67 volts per cell, which is 10V for a 12V battery or 20V for a 24V battery.

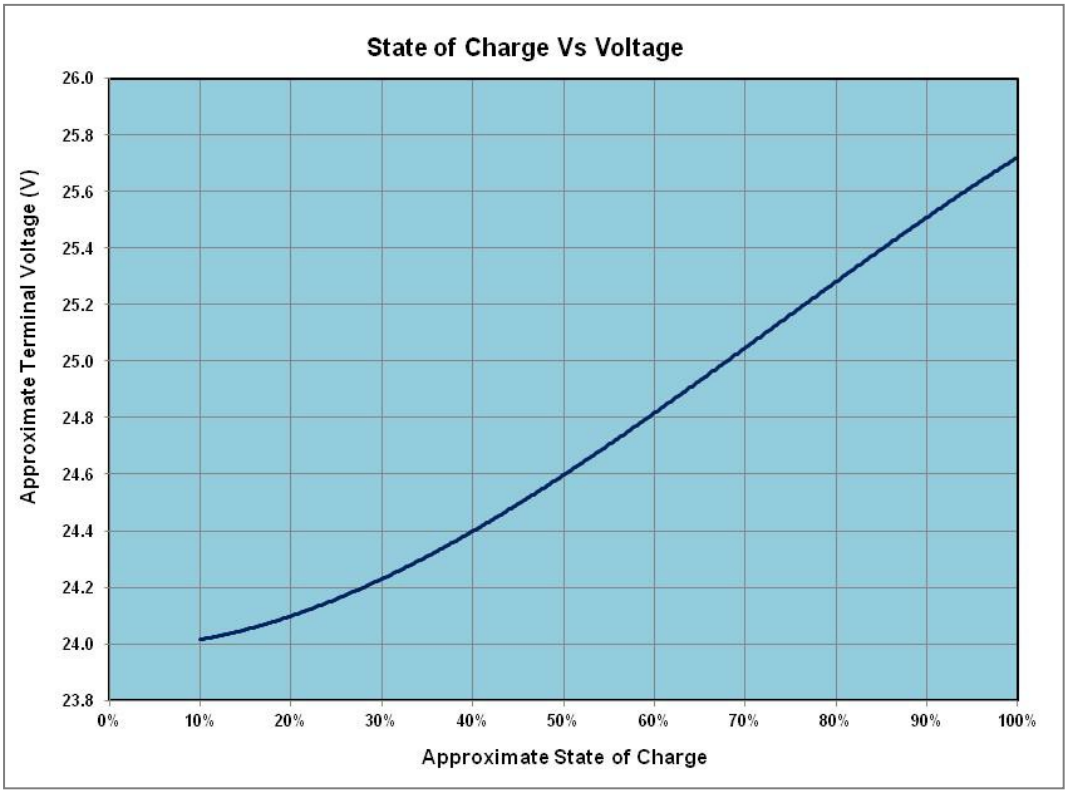
The Emergency Rate is the total essential load, measured in amperes, required to support the essential bus for thirty minutes.

3.2.1.3 **I_{pp}, Peak Power Current**: This is the discharge current delivered at 0.3 seconds while testing during a 15 second power discharge controlled to maintain a constant terminal voltage of half the nominal battery voltage (IEC 60952-1).

3.2.1.4 **I_{pr}, Constant Voltage Current**: This is the discharge current at the conclusion of a 15 second power discharge controlled to maintain a constant terminal voltage of half the nominal battery voltage (IEC 60952-1).

3.2.2 State-of-Charge using voltage measurements should be used as a guide only. Figure 1 (For a 24V battery) indicates the relationship between Battery Open Circuit Voltage (OCV, under no load) and % State-of-Charge (SOC). Please note that State-of-Charge is not the same as available capacity (see GLOSSARY).

Figure 1



Note: Approximate Terminal Voltages would be half these values for a 12V battery. The voltage is read under no load and approximately two hours after any charge or flying session.

3.2.3. All valve-regulated batteries operate best in controlled temperatures. Excessive excursions above 100°F can shorten the life of lead-acid batteries. The optimum operating temperature is around 80°F.

Available capacity declines as the temperature drops. This decline is primarily related to the state of the electrolyte and easily recoverable once the battery has warmed up sufficiently.

SERVICE INSTRUCTIONS

4.1 SHIPMENT OF BATTERIES

4.1.1 The batteries are shipped conditioned and fully charged to distributors who then resell them and aircraft Original Equipment Manufacturers who then install them in new aircraft and/or distribute them for repair and/or upgrade of existing aircraft on a global basis.

4.1.2 Each battery is identified with a unique serial number label and manufacturing date laser etched on the side opposite the positive terminal. Please use this manufacturing date and serial number for future reference.

4.2 INSPECTION FOR SHIPPING DAMAGE

4.2.1 Upon receipt, the packages must be examined for any shipping damage before they are placed in storage or use. If any damage is noted, contact the shipping company and the organization you purchased from immediately.

4.2.2 Type verification can be performed by checking the serial number label on the packaging against the accompanying FAA Form 8130-3 or Certificate of Compliance.

4.3 STORAGE REQUIREMENTS

4.3.1 **Definition:** Storage includes all periods of time (whether stationary or in transport) between the manufacturing date and first installation and any post installation prolonged period of non-use regardless of who is storing the batteries.

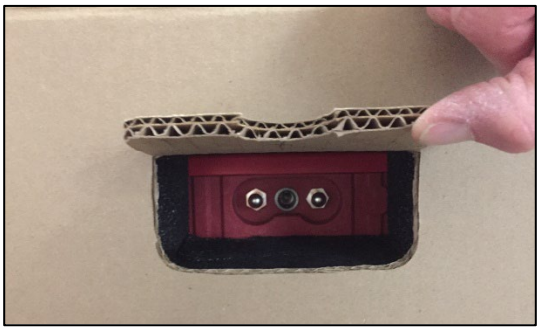
4.3.2 **Storage Temperature Range:** The 7000 series LT VRLA batteries shall be stored between -20°F (-29°C) and +110°F (43.3°C); ideally stored at 70°F (21°C) to 80°F (27°C) to maximize shelf life. Storage at temperatures lower than -20°F (-29°C) or higher than +110°F (43°C), can lead to permanent damage which may render the manufacturer's warranty void.

The actual storage temperature(s) will determine the required period of inspection. Inspection results will determined any required maintenance.

4.3.3 **Shelf Life:** The 7000 series LT VRLA batteries have a pre-installation maximum of 24 months of storage life. They must be installed prior to two years from the manufacturing date or the manufacturer's warranty is rendered void. TBP requires distributors to either sell batteries within 6 months of the manufacturing date or inspect and maintain the batteries per the below criteria. To achieve the maximum pre-installation shelf life of 24 months the battery must be inspected and maintained as described below.

4.3.4 **Inspecting and maintaining battery voltage**: While in storage the battery's voltage will decline with time. Typical time periods of a fully charged battery to fall below 24V or 12V is 6 to 24 months depending on transport and storage temperatures. The higher the ambient temperature the faster the decline. It is important not to let the battery voltage decline too low or damage may occur and the battery may not be recoverable. To maintain acceptable voltage during storage the battery may be left on a float charger in situations where it can be safely monitored using a charger such as TBP's GC Series of chargers per section 5.4.

Alternatively, periodic inspection of the battery voltage can be completed (see 4.3.5). Some LT boxes come with a test flap that allows you to access the battery terminals without opening the box such as shown below.



Check the battery voltage by removing it from the box or by accessing the terminals through the box's test port (where applicable) with a calibrated volt meter.

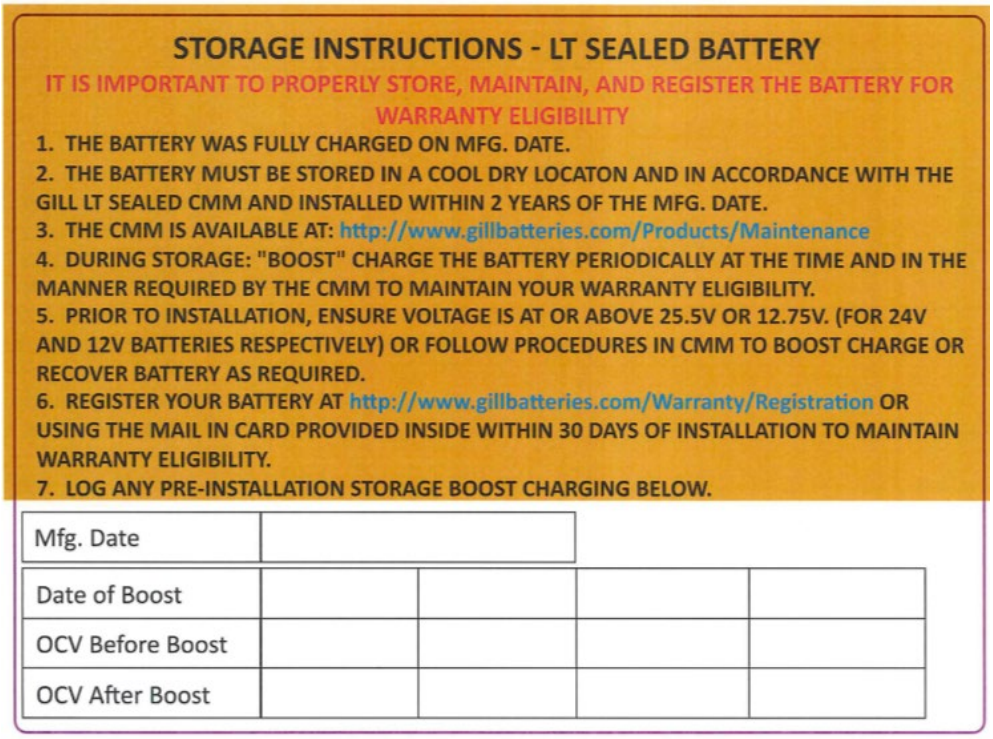
If the battery voltage is below 25.5V for 24V batteries or below 12.75V for 12V batteries follow charging instructions per section 5.5 to maximize shelf life.

While in storage, do not let the battery voltage fall below the point at which discharge is required as defined in section 5.5 and under no circumstances below 18V for 24V batteries or below 9V for 12V batteries.

Warning: While it is acceptable to measure the battery voltage in the box, never charge the battery inside the box.

4.3.5 **Pre-Installation Storage: T**he first inspection is recommended to occur on or before 6 months from manufactured date or from the last manufacturers boost date (whichever is later) documented on the outside of the box on the orange sticker shown below.

If charging is required and completed during storage, log the date, voltage before and voltage after on this same sticker for future reference.



STORAGE INSTRUCTIONS - LT SEALED BATTERY

IT IS IMPORTANT TO PROPERLY STORE, MAINTAIN, AND REGISTER THE BATTERY FOR WARRANTY ELIGIBILITY

1. THE BATTERY WAS FULLY CHARGED ON MFG. DATE.
2. THE BATTERY MUST BE STORED IN A COOL DRY LOCATON AND IN ACCORDANCE WITH THE GILL LT SEALED CMM AND INSTALLED WITHIN 2 YEARS OF THE MFG. DATE.
3. THE CMM IS AVAILABLE AT: http://www.gillbatteries.com/Products/Maintenance
4. DURING STORAGE: "BOOST" CHARGE THE BATTERY PERIODICALLY AT THE TIME AND IN THE MANNER REQUIRED BY THE CMM TO MAINTAIN YOUR WARRANTY ELIGIBILITY.
5. PRIOR TO INSTALLATION, ENSURE VOLTAGE IS AT OR ABOVE 25.5V OR 12.75V. (FOR 24V AND 12V BATTERIES RESPECTIVELY) OR FOLLOW PROCEDURES IN CMM TO BOOST CHARGE OR RECOVER BATTERY AS REQUIRED.
6. REGISTER YOUR BATTERY AT http://www.gillbatteries.com/Warranty/Registration OR USING THE MAIL IN CARD PROVIDED INSIDE WITHIN 30 DAYS OF INSTALLATION TO MAINTAIN WARRANTY ELIGIBILITY.
7. LOG ANY PRE-INSTALLATION STORAGE BOOST CHARGING BELOW.

Mfg. Date				
Date of Boost				
OCV Before Boost				
OCV After Boost				

Adjust subsequent inspection intervals to take into account the batteries' storage environment and maintenance preferences based on results of earlier inspections and the rate of voltage decline noted so long as the absolute minimums noted in 4.3.4 are maintained.

Note that if stored between 95°F (35°C) to 110°F (43°C), the battery must be inspected on a monthly basis. It is not recommended to store any VRLA

batteries at these temperatures for excessive periods of time (max 3 months of storage).

Post installation inspection should occur every 3 months when the aircraft is not in use for prolonged periods.

4.3.6 **Post Installation Storage:** All batteries returned to storage from service use must be stored fully charged per Section 5.2. The storage start date and battery voltage must be logged on the outer package or marked on the battery. The inspection intervals for these batteries will be the same as outlined in this section. See Figure 1 for state of charge at various voltages.

4.3.7 **Effects of Low Temperature Storage**: Long-term storage at low temperatures (around 0°F) will not detrimentally affect the life battery, provided the battery is at a reasonably high state-of-charge (over 80%) before placing in storage. The battery could be stored at lower temperatures but will need to be warmed up to 10°C (50°F) before use.

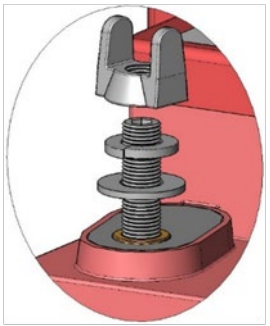
4.3.8 **Further questions**: Please contact TBP Technical Support for any additional questions concerning storage, shelf life or recharge periods.

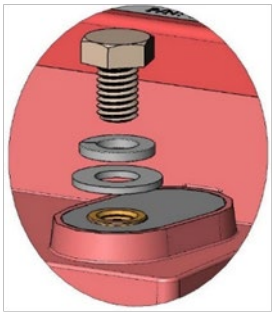
4.4 INITIAL INSPECTION PRIOR TO INSTALLATION

4.4.1 Visually inspect the battery to ensure there is no damage. Remove the protective cap over the terminal pins and ensure that the pins are clean and there is no corrosion. The pins have been installed with the correct torque at the factory and do not require any re-seating.

For the 7025, 7035 and 7200 series of batteries, the terminal connections can be developed in these two ways:

Figure 2


Stud-Wing Nut


Bolt

Inspect the hardware and contact surfaces. Ensure clean surfaces and satisfactory contact of all mating components. Torque settings for the stud /bolt are 50 inch- pounds ± 2 inch-pounds. The wing nut fits a 5/8" or 16mm, 12 point socket.

Call TBP Technical Support if you find any discrepancy.

WARNING

ALL VRLA batteries contain sulfuric acid, which is highly corrosive and can cause serious physical injury if it comes in contact with skin or inhaled. It can also cause serious eye injury or blindness if it comes into contact with the eyes.

Caution must be exercised to avoid damage to the exterior case which could allow the contents to escape or come in physical contact with external materials or personnel.

If a battery case is found to be damaged, handle the battery with care and avoid contact with the skin. Inspect all areas adjacent to the battery for evidence of corrosion.

4.4.2 DO NOT remove factory installed lids. Cell vents are ultrasonically sealed to the cover and cannot be removed for maintenance.

4.4.3 The temperature sensor for the 7638-44T battery is designed to conform to all Citation aircraft battery applications requiring temperature monitoring. Please see the OEM specific CMM for details on the temperature sensor.

4.4.4 Inspect the open circuit voltage. Typical practice should be to recharge the battery at constant potential before placing into service. Review section 5 for all charging instructions.

4.4.5 For basic charging, constant potential is the preferred charging method. Deep-discharge recovery will usually require application of Constant-Current and/or Constant-Potential charging (see Sections 5.3 and 5.4).

4.4.6 If there are any concerns while recharging, please call Tech Support at Teledyne Battery Products.

CHARGING

RECOMMENDATION

Charging should be conducted in a well-ventilated area at ambient conditions ranging from 65ºF to 80ºF.

Warning: Never charge a battery inside its box. Always remove the battery from the aircraft for any charging. Always follow the manufacturer's instructions

5.1 OVERVIEW

5.1.1 Please review the charging method (constant-voltage or constant-current) before commencing. The preferred method is constant-voltage. Refer to Section 5.2 and 5.3.

5.1.2 Correct charging is very important and will affect the overall life of the battery. The charging process is not 100% efficient due to losses resulting from internal resistance and will typically require 10% to 20% more recharge than the amount of capacity removed during discharge.

5.1.3 Undercharging occurs when the battery is repeatedly subjected to time-limited charging; allowing residual lead sulfate to eventually increase in the plates, making it difficult to fully recharge the battery. In this case the battery will suffer a permanent loss of capacity.

5.1.4 Overcharging generally occurs when either constant-current charging is used without adequate control of total time on-charge or the voltage limit in constant-voltage charge is higher than the recommended range (see 5.2.4). Overcharging a battery will corrode the positive grids and break-down the water component in the electrolyte to hydrogen and oxygen (electrolysis). This is quite detrimental to the life of VRLA batteries since the water cannot be replaced.

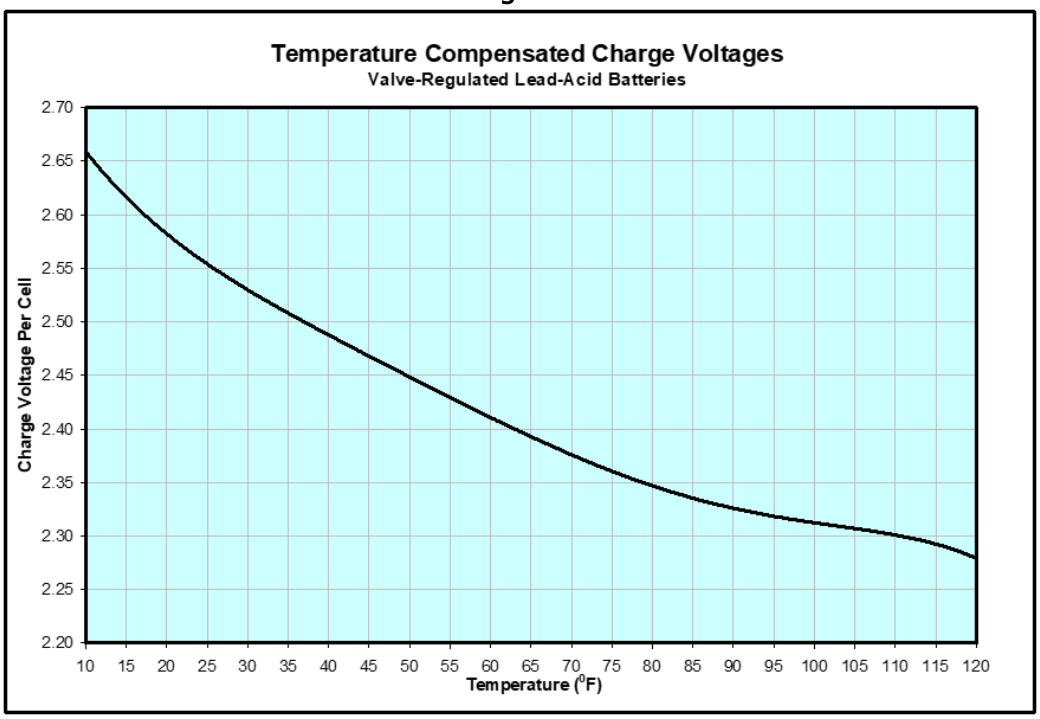
5.2 STANDARD CONSTANT-VOLTAGE (CV)

5.2.1 These chargers are generally designed to provide a constant voltage source, with selectable initial current rates. **See recommended charger voltage output in 5.2.4.** Model variants provide selectable charge voltage and initial charge rates. Higher output current will reduce recharge time.

5.2.2 CV charging starts with a higher initial (inrush) current which starts to reduce as the voltage gradient between the charger and the battery begins to decrease.

5.2.3 Typically the charger will regulate to around 28.6V for 24V batteries or 14.3V for 12V batteries. As the battery approaches the charger output voltage, charge current will decrease steadily to less than 0.5 amperes.

Figure 3



5.2.4 The battery must be charged at Constant Potential with output voltage set between 28.6V ± 0.3V for 24V batteries or 14.25V ± 0.2V for 12V batteries until the charge rate drops below 0.5 ampere.

5.2.5 Once the charge rate is less than 0.5A, disconnect the charger from its power source first before disconnecting the battery from the charger – to eliminate any sparks.

5.2.6 Alternatively, constant-voltage charging can be temperature-compensated for better control. Note Figure 3 for Temperature Compensated Charge Voltages. This figure can be used for all 7000 series batteries.

5.3 STANDARD CONSTANT CURRENT

5.3.1 These types of chargers support a selectable charge rate between 4-10Amps that must be controlled by a timer.

5.3.2 As these chargers maintain the charge rate constant, the on-charge battery voltages could go as high as 34 -35 volts.

5.3.3 The energy restored is measured in ampere.hours – which is the product of the charge rate (A) and the time (hours) of the charge supplied to the battery.

5.3.4 Since these chargers deliver a constant current throughout the charging period, the method can lead to overcharging if it is not controlled.

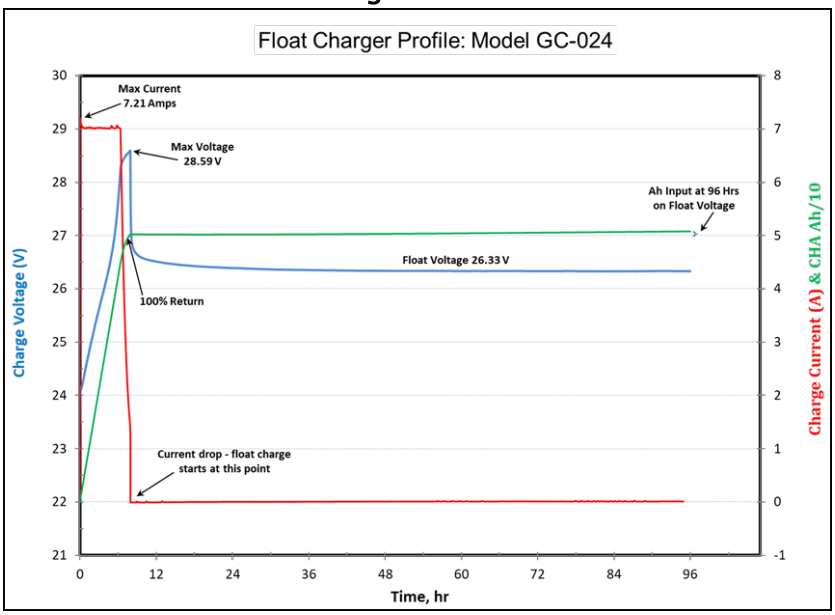
5.4 FLOAT CHARGING

5.4.1 This method of charging is essentially accomplished using a charger that can provide a constant potential charge at a lower voltage, typically around 26.3V ± 0.1V for 24V batteries or 13.2V ± 0.1V for 12V. See Figure 4 for charger performance.

5.4.2 Teledyne recommends using the GC-024 charger, which is a constant potential charger that will revert to a float charger after the battery has been charged at 28.5V ± 0.3V. Gill offers the GC-012 for 12V batteries as well.

5.4.3 The batteries may be kept on the float charger for up to six months at this voltage.

Figure 4



5.5 INITIAL CHARGING BEFORE INSTALLATION

5.5.1 All general charging will be accomplished using the Constant Potential charge regime, except when situations require specific charging treatment. Note: After charging, allow battery to stabilize for at least 2-3 hours before use.

5.5.2 When batteries are left on shelf for a longer period, they will have to be reviewed using open circuit voltage (OCV) as the primary guide, with the State of Charge Vs Voltage graph, Figure 1.

5.5.3 The requirement at initial installation is to ensure battery will provide 100% capacity. Inspect battery voltage and reference to Figure 1 to verify state of charge.

5.5.4 Table 1 provides the necessary charging and / or conditioning that would be required – based on initial battery voltages.

5.5.5 Please contact Teledyne Tech Support if there are any situations that are not clear.

Table 1
STORAGE, BOOST AND INITIAL CHARGING PROCESS

Battery Voltage (Open Circuit Voltage, OCV)	Process
<24V or <12V	Discharge the battery at the one-hour rate to 20V or 10V. Recharge at constant potential (CP) of 28.6V±0.4V or 14.25V ± 0.2V until the charge rate drops to 1A. Then charge at constant current (CC) of 1A for 12 hours. Discharge the battery at the one-hour rate to 20V or 10V (see Appendix A). The battery must achieve at least 100% (1hr) of this rating. - If the battery passes, recharge it using CP and CC method - If not, repeat CP and CC charge followed by one more discharge. If the battery fails to meet capacity, call Teledyne Tech Support for further direction.
24V-25.5V or, 12V-12.75V	Discharge at one-hour rate to 20V or 10V (see Appendix A) – then recharge at constant potential of 28.6V±0.4V or 14.25V ± 0.2V until charge current drops to 0.5A or less. If the charge rate does not drop below required value, generally within 10-12 hours, conduct up to 2 additional capacity tests and verify that the charge rate drops to 0.5A or less.
> 25.5V or >12.75V	Charge at constant potential of 28.6V±0.4V or 14.25V ± 0.2V until charge rate (current) is equal to or less than 0.5A

ROUTINE MAINTENANCE

6.1 POST INSTALLATION INSPECTION/SERVICE PERIOD

After installation of a new battery, Gill requires a capacity check to be performed at 1,800±50 hours or 18 months, whichever comes first, with subsequent capacity checks performed every 900±50hours or 9 months. Please refer to aircraft manufacturer's guidelines for further clarification.

WARNING

The battery must be removed from the installation and serviced in a well-ventilated designated area. During servicing, the battery will generate oxygen and hydrogen gases, which can be explosive under the right conditions.

6.1.1 Battery Integrity

Visually inspect the battery for any signs of cracks, corrosion, unusual terminal pin wear or discoloration on the pins.

WARNING

ALL VRLA batteries contain sulfuric acid, which is highly corrosive and which can cause serious physical injury if it comes in contact with skin or if inhaled. It can also cause serious eye injury or blindness if it comes into contact with the eyes.

Caution must be exercised to avoid damage to the exterior case which could allow the contents to escape or come in physical contact with external materials or personnel.

If a battery case is found to be damaged, handle the battery with care and avoid contact with the skin. Inspect all areas adjacent to the battery for evidence of corrosion.

6.2 CONTINUED AIRWORTHINESS REQUIREMENT – CAPACITY TESTING

During this inspection process, the following components must be reviewed:

6.2.1 Measure and record the battery voltage

6.2.2 Charge the battery using Table 2

Table 2
CHARGING PROCESS

Battery Voltage (Open Circuit Voltage, OCV)	Process
<24V or <12V	First, discharge the battery at the one-hour rate to 20V or 10V. Then, recharge at constant potential (CP) of 28.6V±0.4V or 14.25V±0.2V until the charge rate drops to 1A, followed by a constant current (CC) charge of 1A for 12 hours. Battery is ready for 1st full discharge.
24V-25.5V or, 12V-12.75V	First, discharge the battery at one-hour rate to 20V or 10V (see Appendix A for the discharge rates) – then recharge at constant potential of 28.6V±0.4V or 14.25V±0.2V until charge current drops equal to or less than 0.5A. Battery is ready for 1st full discharge.
> 25.5V or >12.75V	Charge at constant potential of 28.6V±0.4V or 14.25V±0.2V until charge rate (current) is equal to or less than 0.5A

6.2.3 Allow the battery to rest for at least 1 hour before conducting the discharge test

6.2.4 The battery should be discharged (1st discharge) at the one hour rate (see Table 3, Appendix A) to an end voltage of 1.67 volts per cell or 20 volts or 10V (per IEC 60952-1). Measure the time. The battery must achieve at least 80% of the rated time (or 48 minutes at the 1 hour rate).

6.2.5 If the 1st discharge does not deliver at least 48 minutes, the battery should be recharged per section 5.2 and then discharged (2nd discharge).

6.2.6 If the battery does not complete 2nd discharge test satisfactorily, call Gill Technical Support for further details

6.2.7 Once the battery has passed all required inspections and after it is fully recharged using constant-voltage charging methods, the battery is ready for installation.

6.3 RECONDITIONING BATTERY

6.3.1 Discharge the battery at the one hour rate, to the end voltage of 20V (24V battery) or 10V (12V battery). If the battery is already below this voltage, skip this step.

6.3.2 Charge the battery at constant potential of 28.6V±0.4V or 14.2±0.3V, depending on nominal battery voltage until the charge rate drops to 1A, followed by a constant current charge at 1A for 12 hours.

6.3.3 Repeat the discharge per 6.2.4 followed by a recharge per 6.3.2

6.3.4 The battery should achieve full capacity in 2 cycles. If it does not, reject the battery

6.4 DEEP DISCHARGE RECOVERY

6.4.1 Deep discharge is usually indicated by a battery voltage of less than 24 volts or 12 volts, depending on nominal battery voltage. A battery which has been deeply discharged can be recharged using constant-current charging techniques for best recovery.

6.4.2 Discharge the battery at the one hour rate (see Table 3) until the battery drops to 20V (24V batteries) or 10V (12V batteries).

6.4.3 Recharge the battery at a constant current charge rate of 1.0A for a total input (in ampere-hours) of 120% of the one-hour capacity, which is determined as follows:

For example, for a one-hour capacity of 44 Ah, the charge time is determined as follows:

1.2 (120% input) x 44Ah = 52.8 Ah (Ampere-hours) needed.

At the charge rate of 1.0 amperes, the total charge time would be:
52.8Ah/1.0A = 52.8 hours.

Note: Charging the battery at a lower rate is most effective in recovering from a deep discharge.

6.4.4 After a pause of about 1 hour, discharge the battery at the one hour (see Table 3) rate to an end voltage of 10V or 20V, depending on battery nominal voltage. Record the time to the end voltage. If it is greater than 80% of specification (see Appendix A), recharge per Section 5.2 and return to use. If not, continue to 6.4.5.

6.4.5 Charge the battery at constant potential of 28.6V±0.4V or 14.2V±0.3V until the charge rate drops to 1A, followed by a constant current charge at 1A for 12 hours.

6.4.6 Discharge the battery per 6.2.4. If the battery is lower than 80%, recharge per 6.4.5 followed by discharge per 6.4.4, one more time. If the battery does not provide more than 80% of the rated specification, it should be rejected.

6.4.7 If the battery tests fine, recharge the battery per 5.2 (Constant Potential

Charge) before returning the battery to service.

6.4.8 Avoid subjecting a battery to frequent deep discharges as this can reduce useful life of the battery.

6.5 MONITORING BATTERIES IN LONG TERM STORAGE

After storage or before installation on aircraft, follow the guidelines below. Refer to Section 4.3.

6.5.1 If the batteries are stored for two years at recommended temperatures, the batteries can be recharged at constant current of 1A for 120% of the one hour capacity (see Appendix A for specifications). If it is a 27Ah battery, recharge at 1A for:

$$1.2x27/1A = 32.4 \text{ hours}$$

6.5.2 Conduct a capacity check per Section 6.2. Repeat cycle starting with recharge per 6.3.2. The battery should be at capacity by the end of the second cycle. Call Teledyne Tech Support if battery is not at capacity.

6.6 INSPECTION OF CONNECTORS

6.6.1 Before connecting battery to aircraft, ensure the connector sockets have not worn or become loose. Use go-no-go gauge, part number 3600-51, obtained from Teledyne.

6.6.2 For the 7035 and 7200 series, review instructions in 4.4.1

UNSCHEDULED REMOVALS

7.1 Unscheduled removal may be required when the battery has been inadvertently discharged or has a premature failure. Before replacing the battery, use Table 2, to recharge the battery accordingly. Perform a capacity check as outlined in 6.2. If the battery fails to provide specified capacity as noted in Table 3, Appendix A, on page 24, it should be rejected.

7.2 In lieu of the capacity test set forth above, testing on an installed battery may be performed during the 400-hour maintenance check, or the periodic maintenance interval performed by the service center. This test entails a battery OCV check which is compared to the graph in Figure 1 on page 5. If the voltage is below 75% state-of-charge, the battery should be pulled out for servicing as outlined in Section 6.

LT VRLA TROUBLE-SHOOTING GUIDE

PROBLEM	CAUSE	RECOMMENDATIONS
Battery has low capacity	Battery is at end of life.	Replace battery.
	Battery has not been charged correctly	Refer to Section 5 for charging options Repeat as required up to 3 times to achieve capacity.
Will not come up to full charge.	Aircraft charging voltage may be lower than required for application.	Contact Aircraft Technical Support for assistance.
Will not hold charge.	Flight legs too short to charge the battery sufficiently.	Remove the battery from the aircraft and recharge as required.
	Battery held at high ambient temperatures	Remove battery from aircraft, recharge as required.
	Equipment left on accidentally, battery is discharged.	Recharge per Section 5; if deeply discharged, follow Section 6.3.
	Loose connections; corrosion	Clean and neutralize connections; tighten all connections
	Quick disconnect worn beyond tolerance.	Check Cannon or Elcon type connectors for good contact (see 7.2) with Teledyne Go / No-Go gauge part number 3600-51.
	Battery could be shorting under load.	Perform airworthiness test per Section 6.2
	Battery could be self-discharging due to low state of charge. Sulfation can build up – based on repeated undercharge situations – or Excessive sulfation build-up caused by leaving the battery in a discharged state for an extended period of time.	Recharge per Section 5; if deeply discharged, follow Section 6.3.
	Possible excessive use of starter and other electrical equipment.	Remove and recharge the battery; reduce equipment load or use an approved higher capacity battery.
Battery life too short.	Application.	Ensure that battery selection is correct for the application. Infrequent flying will lead to gradual discharge of battery, especially if the breaks between flying are over three weeks. Please review directions under Managing Periods of Non-Use under SERVICE. Ensure battery is not subjected to excessive vibration or high temperatures in service.
	Charging variations such as overcharging or chronic undercharging brought about by short flights.	Overcharging could be eliminated by inspecting and correcting charge voltages. Excessive undercharging (very short flights) should be compensated by periodic charging of battery.

TRANSPORTATION

9.1 Gill LT VRLA batteries are classified as "Nonspillable" and are exempted from all other requirements of 49 CFR, Chapter 1, Subchapter C, Parts 106 – 180, as determined in:

a) Batteries marked "**NONSPILLABLE**" OR "**NONSPILLABLE BATTERY**" are packed and marked in accordance with US Department of Transportation's 49CFR, Chapter 1, Part 173.159, (d)(2)

b) IATA/ICAO, In Accordance with A67 "Not Restricted", Packing Instructions 872. These batteries are not restricted for shipment by Air or any other means of transportation

RECYCLING

10.1 SAFETY DATA SHEETS

10.1.1 The Safety Data Sheets can be downloaded as needed from the Gill website at http://www.gillbatteries.com/

10.2 RECYCLER LOCATIONS

10.2.1 All parts of spent lead-acid batteries are recyclable. Generally, batteries are collected by retailers and wholesalers who send large quantities to battery recyclers for reclamation. Battery recyclers are permitted hazardous waste treatment recycling facilities. If you have just a few batteries you should contact your local battery retailers or wholesalers.

10.2.2 Recycler in California:

RSR Quemetco, Inc.
720 South 7th Avenue
City of Industry, CA 91745
(800)527-9452

10.2.3 The California Department of Toxic Substances Control publishes an annual listing of commercial hazardous waste recyclers, which also includes facilities outside of California. A copy of this publication, the "Directory of Industrial Recyclers" may be obtained by calling (916) 324-2423, or writing to the:

California Waste Exchange Resource Recovery Unit
Hazardous Waste Management Program
Department of Toxic Substances Control
P.O. Box 806
Sacramento, CA 95812-0806

10.2.4 Nation-wide Recycling

Most retailers, auto parts stores or service outlets that sell new lead-acid batteries will accept a small number (one or two) of spent lead-acid batteries for recycling. If you have a larger quantity to be recycled, call to verify that your chosen outlet can handle a larger quantity of old batteries

Even in a state where there is no lead-acid battery recycling law, it's common for battery retailers everywhere in the U.S. to accept used lead-acid batteries

from customers. The spent batteries collected by retailers are shipped to EPA licensed and regulated facilities for recycling.

For additional information, please use the following web address to locate nation-wide recycling facilities: www.batterycouncil.org

10.3 INTERNATIONAL RECYCLING RESOURCES

10.3.1 British Battery Manufacturers Association
26 Grosvenor Gardens
London SW1W 0GT
Direct Tel: +44 (0) 207 838 4800

10.3.2 SNAM (Societe Nouvelle d'Affinage des Metaux)
Rue de la Garenne
St Quentin Sallavier
38297 La Verpilliere Cedex
France
Telephone: + 33 (0)5 65 43 77 30

10.3.3 Recycling facilities can also be located through the following Call2Recycle (a program of Rechargeable Battery Recycling Corporation – RBRC) website: http://www.call2recycle.org/

GLOSSARY

Active material	The formed (charged) material on the positive and negative electrodes (plates).
AGM	Absorptive Glass Mat, a non-woven fiberglass separator that holds the electrolyte.
Ah	Ampere-hour; the standard designation of capacity units for batteries.
CFR	Code of Federal Regulations.
Charge Balance	Net amount of charge "lost"
Electrolyte	The liquid added to a battery that is capable of conducting ions between the two electrodes.
Electrolysis	Decomposition of an electrolyte by the action of an electric current flowing through the electrodes (positive and negative plates).
IATA	International Air Transport Association.
ICAO	International Civil Aviation Organization.
IEC	International Electrotechnical Commission.
I_{pp}	Peak current delivered at 0.3 seconds into a 15 second controlled discharge at a constant terminal voltage of half the nominal battery voltage.
I_{pr}	Discharge current at the conclusion of a 15 second controlled discharge at a constant terminal voltage of half the nominal battery voltage
Nonspillable	Refers to the ability of the battery to retain the electrolyte when subjected to tests identified under US DOT Reg. 49 CFR, Part 173.159, paragraph "d".
OCV	Open Circuit Voltage; measured with no loads connected to the battery.
Passivation	Refers to the oxidation of the negative electrode.
Recombination	The process by which oxygen combines (reacts) with the negative active material.
Sponge lead	Fully charged negative plates convert to a very porous pure lead material, often referred as sponge lead since it resembles a sponge under high magnification.
State of Charge	The state-of-charge is the ratio between the difference of the rated capacity and the charge balance to the rated capacity.
Sulfation	The product of discharge, lead sulfate, formed on both positive and negative plates.
Venting	Means for a battery to release the gases it generates during charging.
VRLA	Valve-Regulated Lead-Acid

APPENDIX A

Table 3
VRLA Battery Capacities

Battery Model	Battery Voltage (V)	1 Hour Rate (C1) (A)	30 Minute Rate (A)
7025-20	12	20	32
7025-24	12	24	38
7035-28	12	28	45
7035-34	12	34	55
7242-14	24	14	22
7242-16	24	16	25
7243-14	24	14	22
7243-16	24	16	25
7243-16T	24	14	22
7246-20	24	20	35
7246-20AT	24	20	35
7407-28	24	28	45
7639-25	24	25	45
7639-27	24	27	45
7639-30LT	24	30	50
7639-34	24	34	55
7641-20	24	20	35
7638-36	24	36	63
7638-44	24	44	70
7638-44T	24	44	70
7638-44ST	24	44	70
7638-48P	24	48	75
7638-53	24	53	80

APPENDIX B

For VRLA Battery Specifications and Performance Curves: See applicable Specification Sheets at http://www.gillbatteries.com/