TELEDYNE BATTERY PRODUCTS
Everywhereyoulook™

COMPONENT MAINTENANCE MANUAL

14Ah Valve-Regulated Lead-Acid Battery

Teledyne Battery Part Number: 7243-16T

TABLE OF CONTENTS

Section	Description	Page
1	Revisions	1
2	Scope	2
3	Description of Valve-Regulated Lead-Acid batteries	3
	Definition of Specifications	4
	State of Charge Vs Voltage	5
4	Service Instructions	6
5	Charging, Constant Potential	9
	Charging, Constant Current	11
6	Routine Maintenance	13
	Continued Airworthiness Testing	13
	Deep Discharge Recovery	16
	Reconditioning Battery	16
7	Unscheduled Removals	17
8	Transportation	18
9	Recycling	19
10	Glossary	21
11	Appendix A	22

COMPONENT MAINTENANCE MANUAL

REVISIONS

Revision	Description of Change	Approved By	Date
NC	New document	JMR	4-15-16
A	Revised document number -first two pages	JMR	6-9-16

SCOPE

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

This manual has been written for the purpose of guidance only; consult Teledyne Battery Products (TBP) Technical Support for further information.

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 an optimum lead alloy with tin and copper to provide the best possible electrode characteristics necessary for performance. These LT-VRLA batteries contain electrolyte absorbed in glass-mat 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 twelve cells connected in series internally, making up a 24V battery. These cells are not replaceable.

3.1.5. Each cell is constructed of premium grade LT electrodes (plates) that are electrically isolated by AGM separators.

3.2 DEFINITION OF SPECIFICATIONS

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 a battery can endure for one hour with the battery voltage at or above 1.67 volts per cell, or 20 volts for a 24 volt lead-acid battery.

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

3.2.1.2 **The Emergency Rate**
This is the rate of discharge a battery can endure for thirty minutes with the battery voltage at or above 1.67 volts per cell, or 20 volts for a 24 volt lead-acid battery.

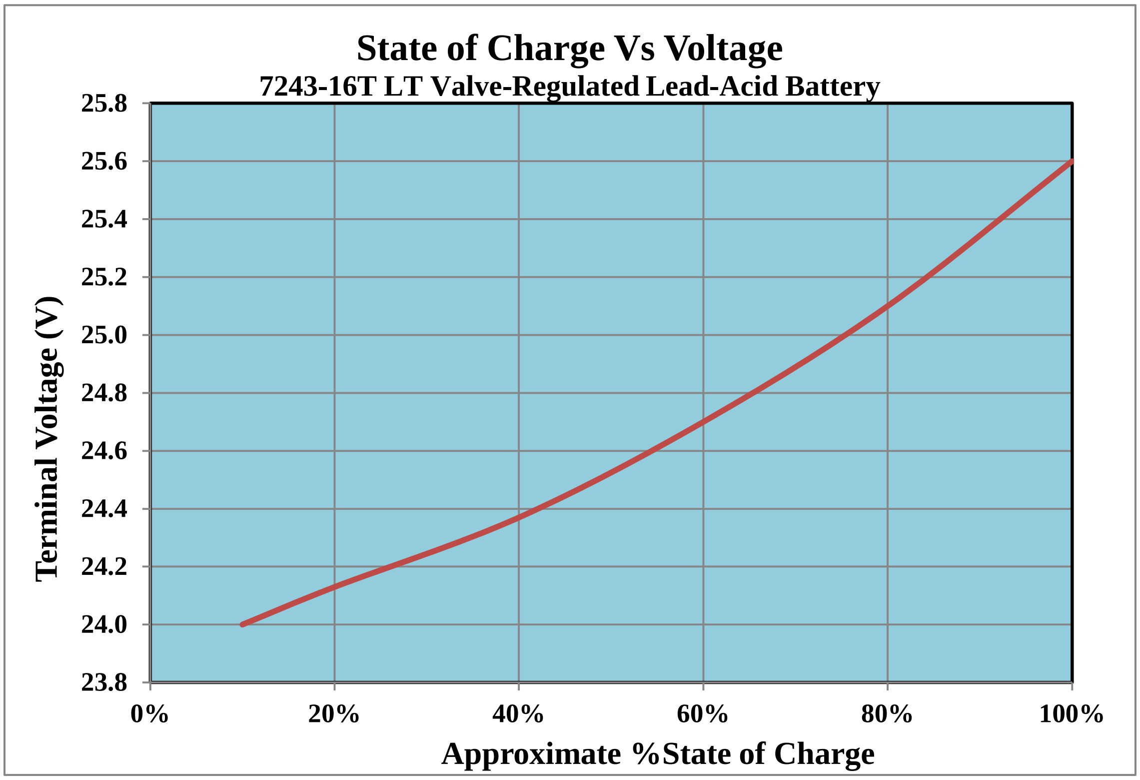
The Emergency Rate is the total essential load, measured in amperes, required to support the essential bus for thirty minutes.

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.

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.

3.2.2 State of charge using voltage measurements should be used as a guide only. Figure 1 indicates the relationship between Battery Open-Circuit Voltage (OCV) and % State-of-Charge (SOC).

FIGURE 1



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

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.

4.1.2 Each battery is identified with a unique serial number label and manufacturing date marked with indelible ink on the right side of the battery (side adjacent to the positive terminal, with the terminals facing forward). Please use this manufacturing date 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 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 TBPs 7000 series LT VRLA batteries can be stored between -20ºF and +110ºF (store ideally at 80ºF). Storage at temperatures other than these, can lead to permanent damage.

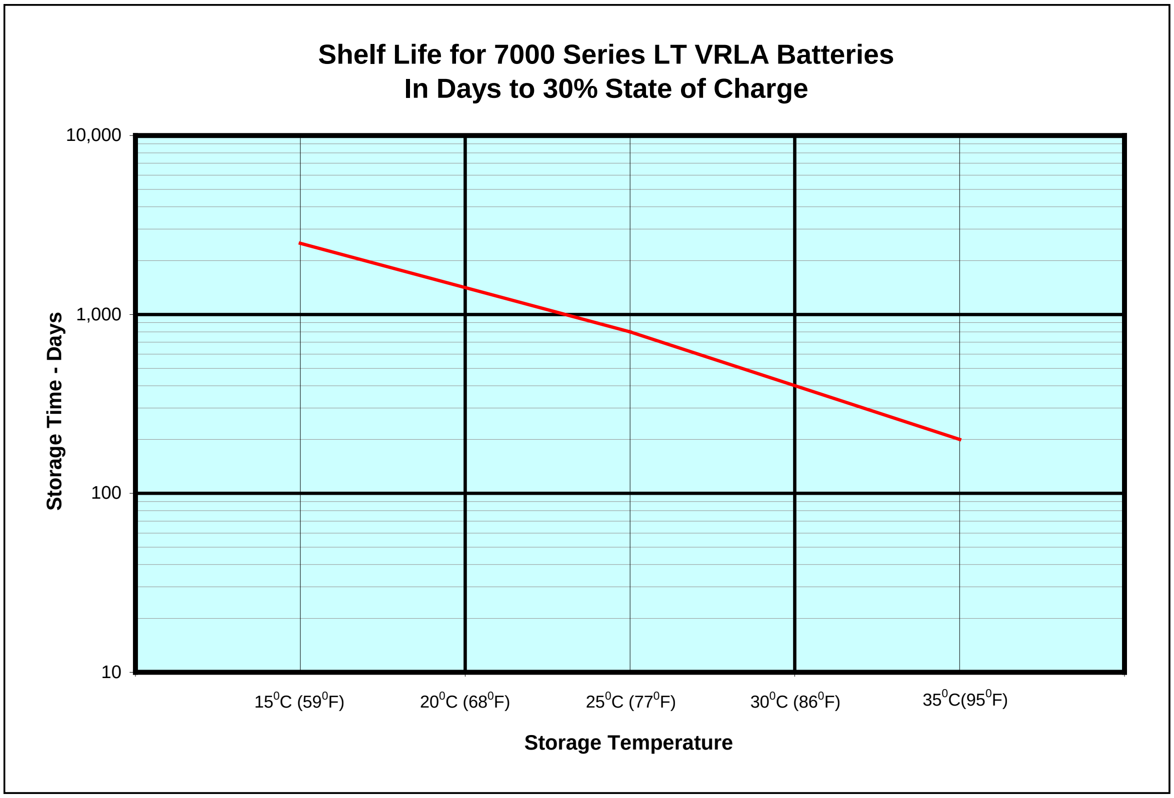
Storage temperatures will determine inspection requirements.

4.3.2 TBPs 7000 series LT VRLA batteries have a maximum of 24 months of inspection-free storage life, IF stored at temperatures between 40ºF to 80ºF.

Batteries maintained at lower temperatures should be reviewed in this category as well.

4.3.3 Review Figure 2 to determine the shelf life at various temperatures indicated. The 7000 series LT VRLA batteries can be stored for the number of days at the temperature indicated in Figure 2 without any damage.

FIGURE 2



4.3.4 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 (maximum 3 months storage). Prolonged storage at high temperatures (over 110°F) will reduce battery life.

4.3.5 All batteries returned from service after initial use must be stored fully charged. The storage start date and battery voltage must be logged on the outer package or marked on the battery.

4.3.6 Long term storage at low temperatures (around 0°F) will not detrimentally affect the life of the battery, provided the battery is at a reasonably high state of charge (over 80%) before placing in storage.

4.3.7 Please call TBP technical support if there are any questions regarding shelf life and recharge periods.

4.4 INITIAL INSPECTION

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. Call TBP Technical Support if you find any discrepancy.

4.4.2 The vents are sealed in the cover and cannot be removed for maintenance.

4.4.3 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.

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 Section 6.4). Please consult with technical support at TBP before attempting recovery from prolonged deep-discharge.

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.

4.4.4 Charging should be terminated when the charge current drops to less than 0.5 amperes (may take up to 15 hours depending on the state-of-charge of the battery).

CHARGING

RECOMMENDATION

Charging should be conducted in a well-ventilated area at ambient conditions ranging from 65⁰F to 80⁰F.

5.1 OVERVIEW

5.1.1 Please review the charging method (constant-current or constant-voltage) before commencing. The preferred method is constant-voltage. Reference 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 Section 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.

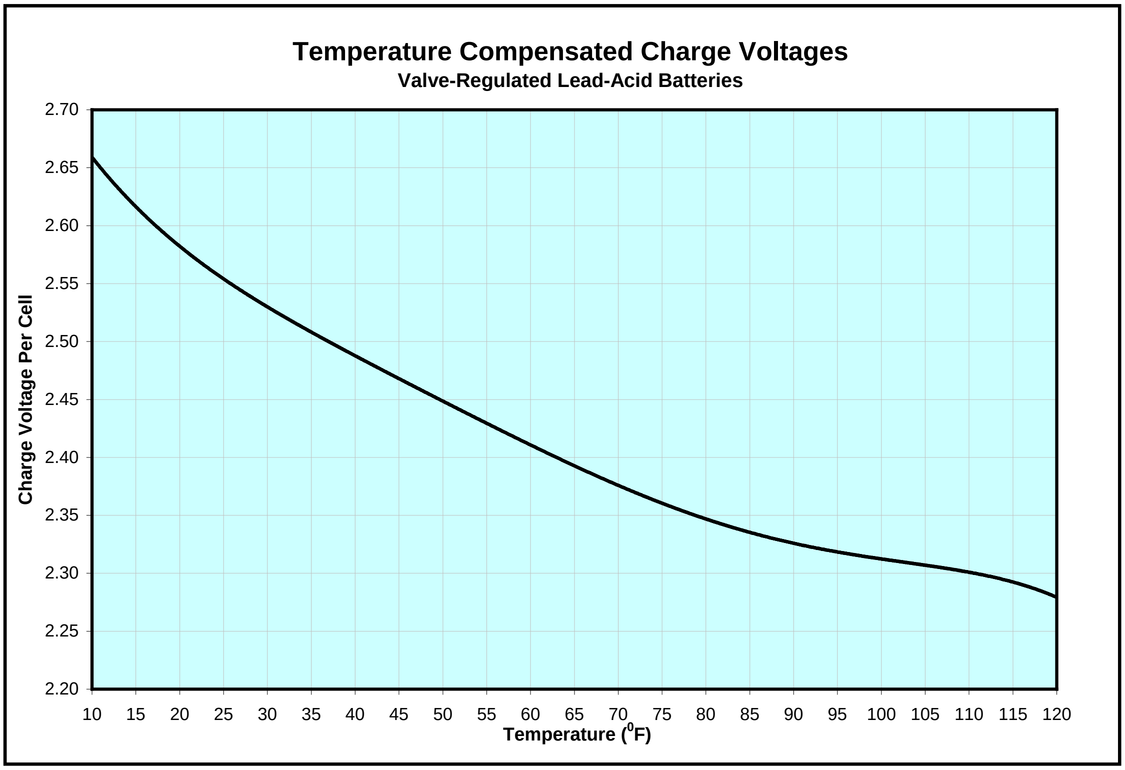
5.2 STANDARD CONSTANT-POTENTIAL (OR CONSTANT VOLTAGE, CP OR CV)

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

5.2.2 CV charging will result in a high initial charging current which will start dropping off when the voltage gradient between the charger and battery begins to decrease because the current in any circuit is directly proportional to the voltage gradient across that circuit.

5.2.3 Typically, the charger will regulate to around 28.6 volts. As the battery approaches the charger output voltage, charge current will drop below 0.5 ampere.

FIGURE 3



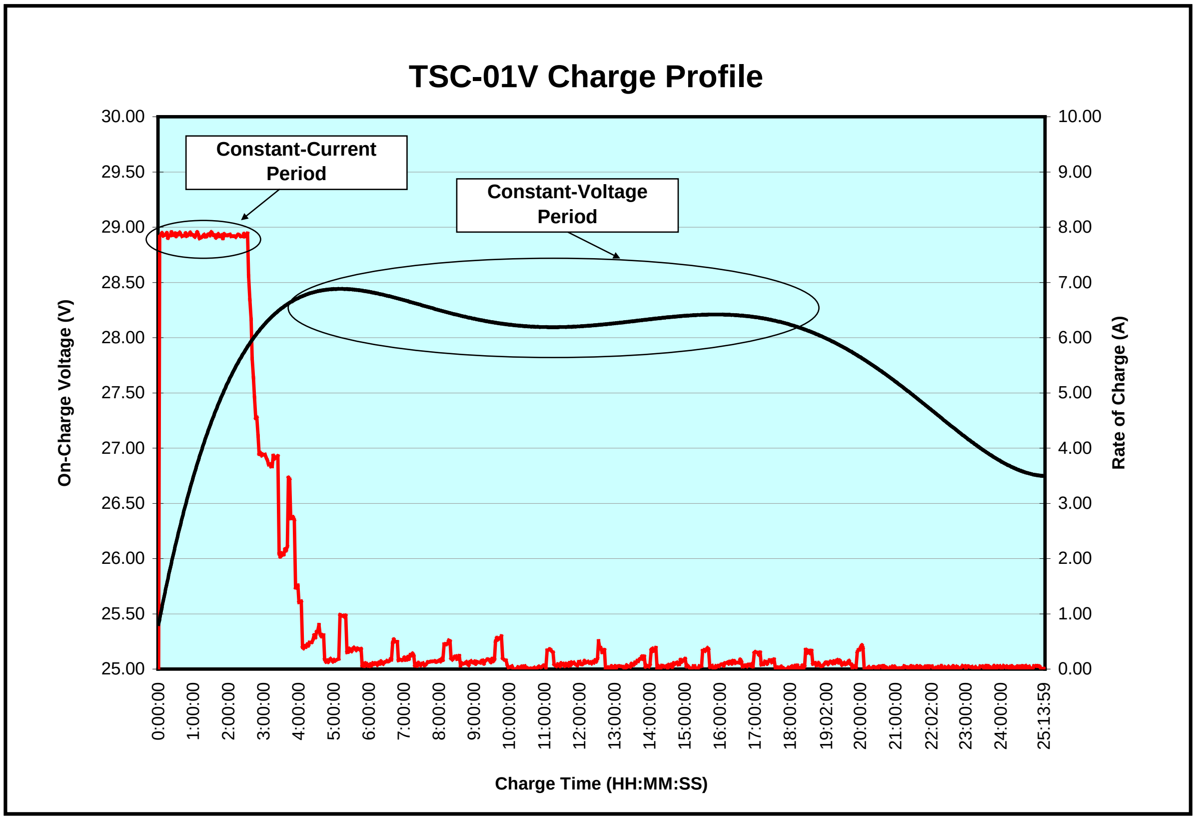
5.2.4 The battery must be connected to the charger with output voltage set between 28.2V up to 29.0V for 24V batteries and left on until the charge rate drops below 0.5 ampere. At this point, disconnect the charger from its power source first before disconnecting the battery from the charger – to eliminate any sparks.

Note: Unless the charger is of a type that turns off automatically, the charger and battery must be disconnected once the charge rate drops below 0.5 ampere.

5.2.5 Alternatively, constant-voltage charging can be temperature-compensated for better control. Note Figure 3 for Temperature Compensated Charge Voltages.

5.2.6 Figure 4 represents TBPs TSC-01V Charger profile. This is a specialized charger that provides a constant-current charge initially; there-after, it switches to constant-voltage charge to the battery.

FIGURE 4



5.2.7 Teledyne also provides the TDMC-90 charger that supports both constant current and constant potential charging in the same unit. This charger is recommended for all LT-VRLA batteries.

5.3 STANDARD CONSTANT-CURRENT (CI)

5.3.1 These chargers must be capable of providing an output of ~ 35 volts and ~ 8 amperes (with selector switch) and include a timer that can terminate charging when the required charge input is attained.

5.3.2 The ampere hours of energy restored is the product of charge current (in amperes) and the time (in hours).

5.3.3 Since these chargers are designed to provide a constant current throughout the charging period, this method can lead to overcharging if not controlled. In order to control the charge input, these chargers must have a shut-off timer.

5.4 INITIAL CHARGING

5.4.1 All general charging will be at accomplished using the Constant Potential charge regime. Based on voltage, the battery should be charged as shown in Table 1.

Table 2
INITIAL CHARGING PROCESS

Battery Voltage	Process
<24V	Call Tech Support at Teledyne Battery Products. [The battery will need to be charged at constant current (1A) followed by the discharge and recharge as shown below].
24V-25.8V	Charge the battery at constant potential of 28.2 to 29 volts; Discharge at one-hour rate to 20V - then recharge at constant potential of 28.2 volts to 29 volts until charge current drops equal to or less than 0.5A. If after 12 hours of charge, the charge rate does not drop below required value, repeat for up to 6 discharge-charge cycles until charge current drops below 0.5A. If the batteries have been stored for extended periods of time (greater than 120 days), a capacity check will be essential to ensure the batteries are properly conditioned - as monitored during the cycling process. Verify that the battery provides design capacity. The battery should be conditioned within 2 cycles.
25.9V-26.2V	Charge at constant potential of 28.2 volts to 29 volts until current drops to 0.5A

ROUTINE MAINTENANCE

6.1 INSPECTION/SERVICE PERIOD

After initial installation, Gill requires a capacity check of the battery to be performed at 900±50 hours or 12 months, whichever comes first, with subsequent capacity checks performed every 450±50 hours or 6 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

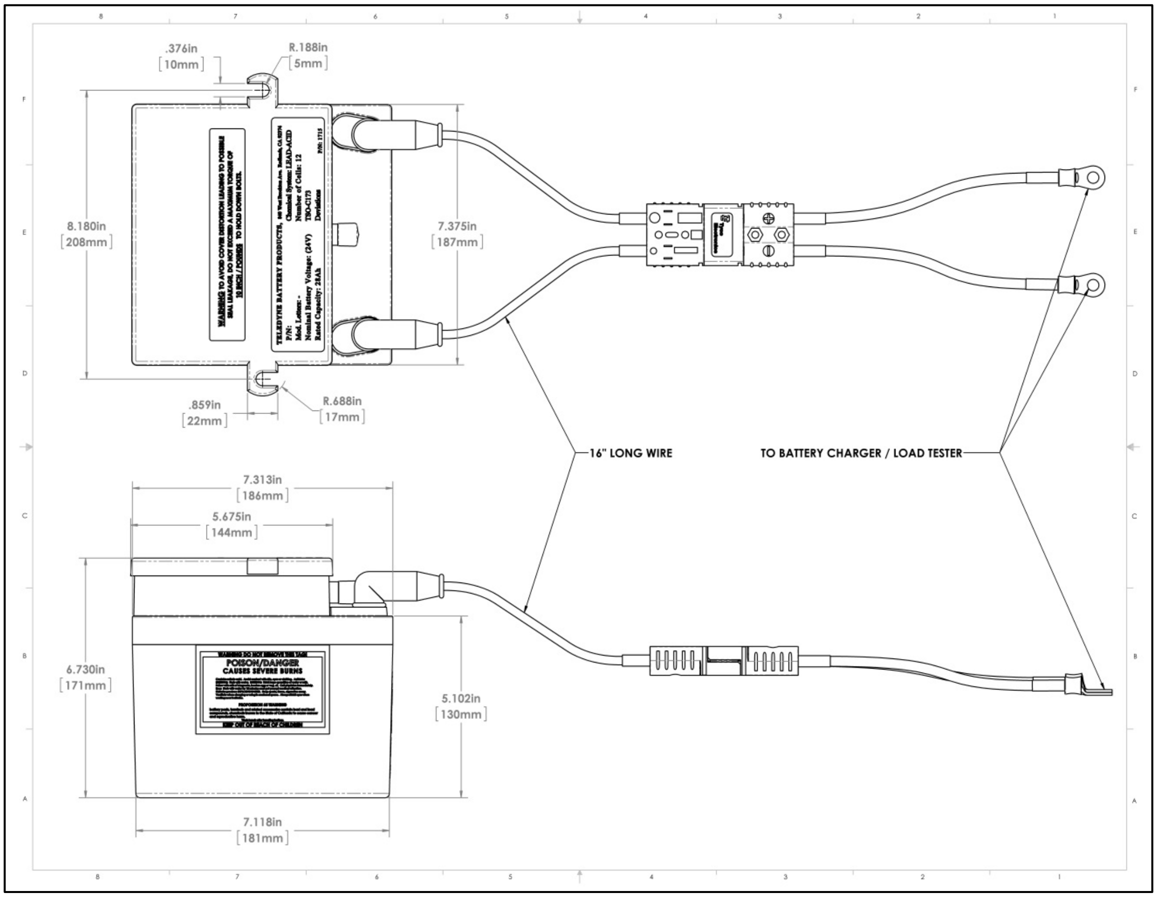
During this inspection process the following components must be reviewed:

6.2.1 Measure and record the battery voltage.

6.2.2 Charge the battery using Constant-Voltage or Constant-Current method described in Section 5.

Prepare a connector – as shown in Figure 5, for connecting the battery to a charger or load tester.

FIGURE 5



6.2.3 Allow the battery to rest for 1 hour before starting the discharge test.

6.2.4 The battery should be discharged at the one hour rate (see Table 2, Appendix A) to an end voltage of 1.67 volts per cell or 20 volts (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).

If the first discharge time is less than 48 minutes, condition charge the battery per Section 5.4, Table 2 and repeat the test. Alternatively, if the batteries are close to just 80%, they may need reconditioning. Use the procedure outlined in Section 6.5 to obtain the best possible conditioning of these batteries to ensure capacity that is better than 80%.

6.2.5 If the second discharge fails to deliver at least 48 minutes, the battery should be rejected. Call Gill Technical Support for further details.

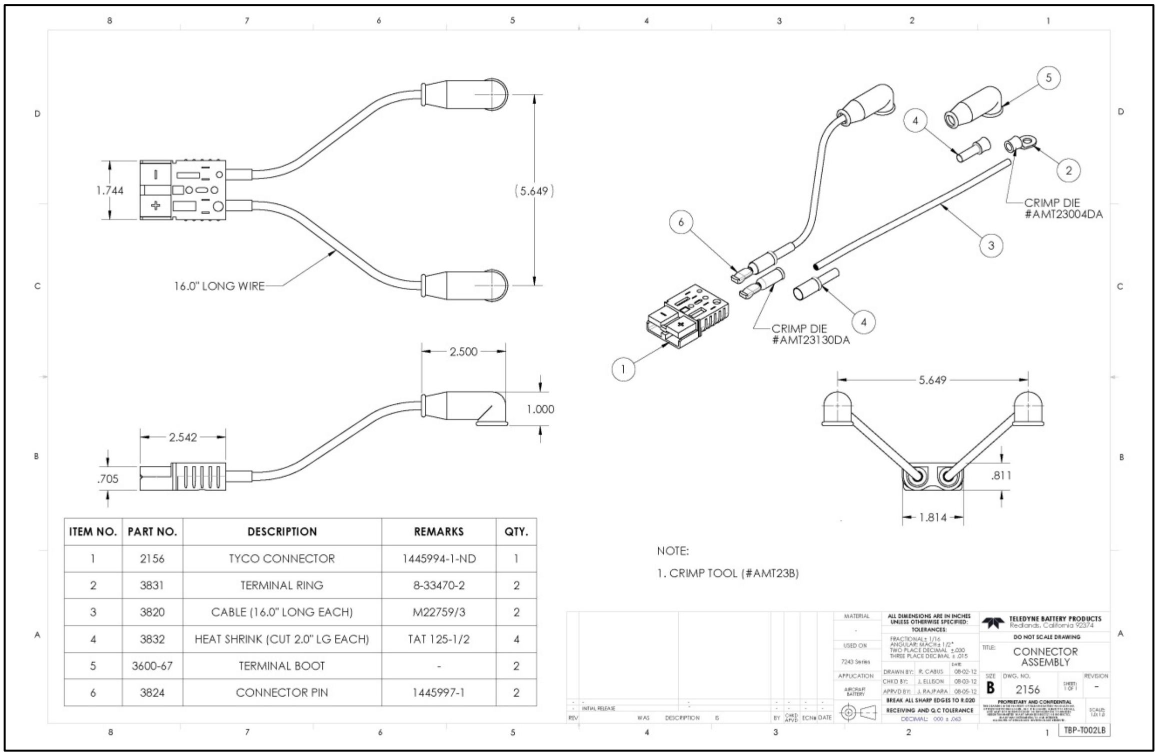
6.2.6 If the discharge cannot be conducted according to the rates required, Teledyne Gill can provide the appropriate discharge curve for that battery and suggest alternative rates. Call Gill Technical Support for additional instructions.

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 INSPECTION OF CONNECTORS

6.3.1 This battery is equipped with TYCO connector, part 1445994-1. Visually inspect the connector pin, part 1445997-1, for wear – see connector drawing, Figure 6. Replace if worn.

Figure 6



ITEM NO.	PART NO.	DESCRIPTION	REMARKS	QTY.
1	2156	TYCO CONNECTOR	1445994-1-ND	1
2	3831	TERMINAL RING	8-33470-2	2
3	3820	CABLE (16.0" LONG EACH)	M22759/3	2
4	3832	HEAT SHRINK (CUT 2.0" LG EACH)	TAT 125-1/2	4
5	3600-67	TERMINAL BOOT	-	2
6	3824	CONNECTOR PIN	1445997-1	2

6.4 DEEP-DISCHARGE RECOVERY

6.4.1 Deep discharge is usually indicated by a battery voltage of less than 21 volts. A battery which has been deeply discharged can be recharged using constant-current charging techniques for best recovery.

6.4.2 The battery should be charged at a 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.

6.4.3 Stable voltage, measured 2 hours after charge termination, should be between 25.8 V to 26.2V. If the voltage falls below the range specified, recondition the battery using guidelines in Section 6.5.

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

6.5 RECONDITIONING BATTERY

If the battery voltage is below 25V, the battery could be processed as follows:

6.5.1 Discharge the battery at the one hour rate, to the end voltage of 20V.

6.5.2 Charge the battery at constant potential of 28.5V± 0.3V for 2 hours, followed by a constant current charge at 1A for 12 hours.

6.5.3 Repeat the discharge test per Section 6.2.4, followed by a recharge per Section 6.5.2.

6.5.4 The battery should achieve greater than 80% capacity in about 2 cycles. If it does not, reject the battery.

UNSCHEDULED REMOVALS

7.1 Unscheduled removals may be required when the battery has been inadvertently discharged or has a premature failure. Recharging the battery using Constant Potential method described in Section 5.2 should be attempted. Perform a capacity check as outlined in Section 6.2. If the battery fails to provide specified capacity as noted in Table 2, Appendix A, 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 450hour ± 50hour 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. If the voltage is below 75% state-of-charge, the battery should be pulled out for servicing as outlined in Section 6.

TRANSPORTATION

8.1 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) US Department of Transportation's 49CFR, Chapter 1, Part 173.159, paragraph "d"
b) IATA/ICAO Packing Instructions 806, Provision A67

RECYCLING

9.1 SAFETY DATA SHEETS

9.1.1 The SDSs can be downloaded as needed from the Gill website:
www.gillbatteries.com

9.2 RECYCLER LOCATIONS

9.2.1 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.

9.2.2 Recycler in California:

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

9.2.3 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

9.2.4 **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

9.3 INTERNATIONAL RECYCLING RESOURCES

9.3.1 British Battery Manufacturers Association
26 Grosvenor Gardens
London SW1W 0GT
Direct Tel: +44 (0) 207 838 4800
Direct Fax: +44 (0) 207 838 4801

9.3.2 SNAM (Societe Nouvelle d'Affinage des Metaux)
Rue de la Garenne
St Quentin Sallavier
38297 La Verpilliere Cedex
France
Telephone: 00 33 74 945 985
Battery re-processing.

9.3.3 You can also locate a recycling facility through the following Call2Recycle (a program of Rechargeable Battery Recycling Corporation – RBRC) website: http://www.call2recycle.org/

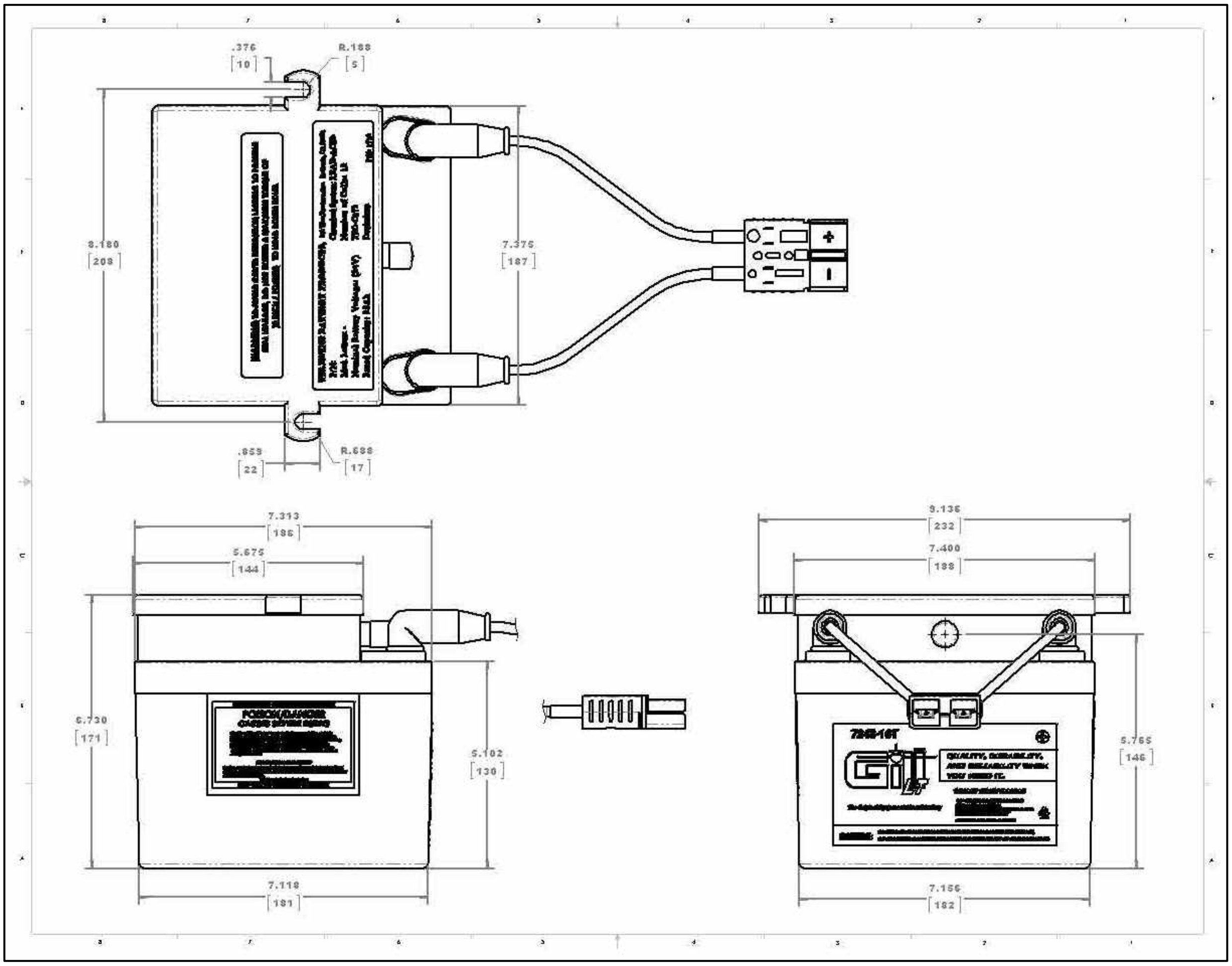
GLOSSARY

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.

APPENDIX A

TABLE 2

7243-16T Specifications



Weight (Max) lb	Rated Capacity (Ah)	Power Rating				Minimum Capacity for Airworthiness (Ah)
			24°C	-18°C	-30°C	
30.5	14	I_{pr}	480	300	250	11.2
		I_{pp}	1,100	640	495	