HAWKER

Sealed Lead Acid Batteries

Aircraft Battery Maintenance Manual

UK

EnerSys®
Power/Full Solutions
AEROSPACE

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IMPORTANT

Please read this manual immediately on receipt of the battery(ies) before unpacking and installing. Failure to comply with these instructions will render any warranties null and void to the extent permitted under applicable law. The manufacturer has not created any obligations under this manual in the event the battery is damaged or destroyed as a result of any misuse or not following the instructions

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ABBREVIATIONS

A	Amperes
AGM	Absorbed Glass Mat
Ah	Ampere-hour
CV	Constant voltage
OCV	Open Circuit voltage
TPPL	Thin Plate Pure Lead
V	Volts
VRLA	Valve Regulated Lead Acid

1. SCOPE

The manual describes the processes for trained technicians to maintain Hawker® sealed lead acid batteries as defined in appendix A, and covers their basic design features, maintenance, storage, transportation and ultimately the disposal requirements of the battery.

Only trained staff should have access to the manual, which always shall be of latest revision and kept in good condition by the battery owner.

2. INTRODUCTION

The Hawker® battery is a valve regulated lead acid (VRLA) system, using absorbed glass mat (AGM) to retain the electrolyte. The battery operates on the principle of gas recombination resulting in minimal gas evolution during normal operation. The battery is fully compatible for use on aircraft, which may perform aerobatic manoeuvres.

The battery is maintenance free with respect to electrolyte replenishment. Under no circumstances should any attempt be made to interfere with construction or introduce any substances, e.g. acid, distilled water or alkali, to the battery.

3. BATTERY DESCRIPTION

The Hawker® 24 volt aircraft battery covered by this maintenance manual consist of two 12 volt valve regulated monoblocs connected in series, enclosed in a polyester bonded fibreglass case which incorporates the battery main terminal connector. The monobloc design is based upon a Thin Plate Pure Lead (TPPL), valve regulated, lead acid system.

Each 12 volt monobloc consists of six 2 volt cells internally connected in series to make a 12 volt block. The individual 2 volt cells are not replaceable. The cells within the monoblocs are interconnected with through-the-partition-wall weld connections.

The cells are manufactured with proprietary VRLA AGM technology that can deliver high performance engine start capability in excess of $50C_1$ amps at normal temperature and superb durability under emergency load conditions.

Thin fiberglass separators are placed between the positive and negative plates. The tightly packed plates and separator form a compressed and rugged construction, which enhances the battery's resilience to vibration.

4. SAFETY INSTRUCTIONS

	• Pay attention to the operating instructions and keep them close to the battery. • Work on batteries must only be carried out by skilled personnel!
	• Use protective glasses and wear safety clothing when working on batteries. • Adhere to the current accident prevention rules in the country where the battery is used.
	• No smoking! • Do not expose batteries to naked flames, glowing embers or sparks, as it may cause the battery to explode. • Avoid sparks from cables or electrical apparatus as well as electrostatic discharges.
	• Acid splashes into the eyes or on the skin must be washed immediately with an abundance of clean water. After abundant flushing consult a doctor immediately! • Clothing contaminated by acid should be washed in water.
	• Electrolyte is highly corrosive. • In the normal operation of this battery, contact with acid isn't possible. If the cell containers are damaged, the immobilised electrolyte (absorbed in the separator) is corrosive like liquid electrolyte.
	• Batteries and monoblocs are heavy. • Use suitable transportation/lifting equipment.
	• Risk of explosion and fire. • Avoid short circuits: do not use non-insulated tools, do not place or drop metal objects on top of the battery. Remove rings, watches and articles of clothing with metal parts that might come into contact with the battery terminals.
	• Avoid short circuits: Hawker TPPL batteries are capable of high short circuit currents. • Caution - metal parts of the battery are always live: do not place tools or other objects on the battery!
	• Pay attention to the hazards that can be caused by batteries.

5. SPECIFICATIONS

5.1 CAPACITY

The capacity of Hawker® VRLA aircraft battery is rated in ampere-hours at the 1-hour rate (AhC_1). An 18 ampere-hours battery will sustain an 18-ampere discharge for 1 hour down to a battery voltage of 20 volts. By conventional definition, the battery is deemed airworthy if it delivers its rated capacity for 48 minutes down to a voltage of 20 volts at +20°C i.e. 80% nominal C_1 capacity.

5.2 TEMPERATURE EFFECT

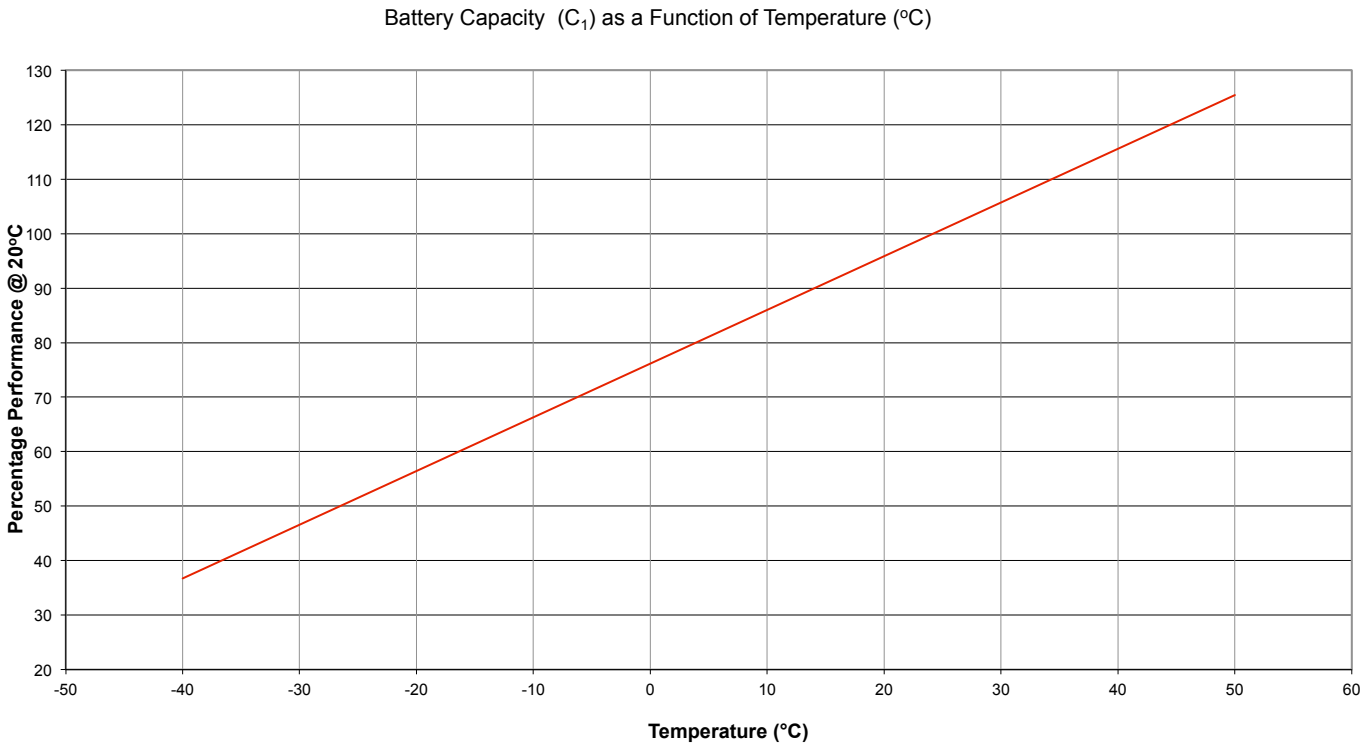
The ideal environmental temperature range for battery operation is 23°C to 25°C; temperatures outside this range have an effect on the life and performance of the battery. These effects are detailed in figure 1:

Figure 1- Temperature effect

-40°C to 22°C	23°C to 25°C	26°C to 50°C
Reduced Capacity Undercharge Reduced life	Optimum life & Performance	Increased Capacity Overcharge Reduced life

The figure 2 illustrates the relationship between battery capacity and temperature. A reduction in capacity and performance will be experienced as the temperature falls from the nominal operating temperature. Conversely, as the temperature increases the capacity and performance of the battery will also increase. These conditions are not permanent; the capacity will be restored as the temperature returns to the nominal operating temperature range.

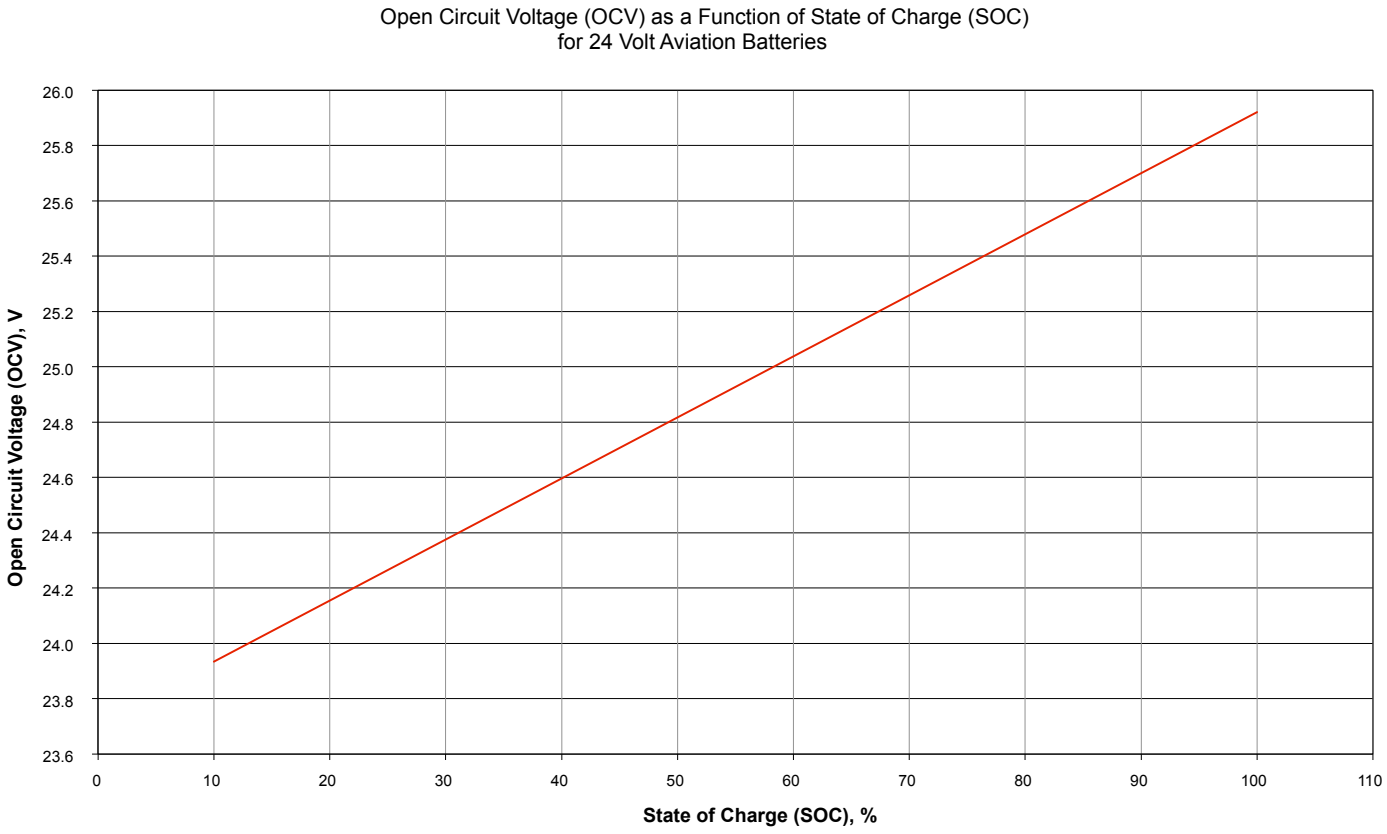
Figure 2 - Battery capacity as a function of temperature



5.3 STATE OF CHARGE

The open circuit voltage of the battery prior to service can be used as an approximate guide to the state of charge of the battery. Figure 3 shows the relationship between open-circuit voltage and the state of charge of a new battery after 24 hours or more after recharge.

Figure 3 - Open circuit voltage as a function of state of charge



Note! *That state of charge is not the same as available capacity. A battery at end-of-life and fully charged will show an OCV of 26.0V approximately but have an available capacity of 80% of rated capacity.*

6. STORAGE

The battery/re-blocking kit should be stored, fully charged, in a cool dry place, ideally below 25°C. The battery/re- blocking kit charge retention will be reduced and possible performance degradation will occur if it is subjected to long-term exposure well in excess of this temperature.

The battery/re- blocking kit has a maximum inspection-free storage life of two (2) years, if stored at or below 20°C, after which a boost charge should be administered in accordance with paragraph 9. However, it is advisable to conduct an inspection and open circuit voltage check after 12 months and top-up charge in accordance with paragraph 9 if necessary.

The battery/re-blocking kit may be stored up to five (5) years without degradation of performance provided that an inspection and open circuit voltage check is conducted every 12 months. When stored in temperatures in excess of 25°C the battery/re-blocking kit should be inspected every 6 months, and top-up charged in accordance with paragraph 9 should the open circuit voltage fall below 25.5 volts for an assembled battery or 12.75 volts for individual monoblocs.

Should the battery be returned to storage following in service use, it must be fully recharged in accordance with paragraph 9 and if possible packed in original packaging.

7. CONDITION OF BATTERIES ON RECEIPT /ACCEPTANCE CHECKS

All batteries as dispatched are in a fully charged condition, the date of the latest charge being marked on the outer packaging and on the battery instruction label.

If the battery is received within three months of the latest charge, the only acceptance check required immediately upon receipt is inspection of the box for damage during shipping. The battery **does not** have to be unpacked.

The battery labels show: -

- Type of battery (i.e. Lead acid - aerobatic)
- Manufacturer's name
- Manufacturer's type or product number
- Manufacturer's serial number
- Date of manufacturer's last charge
- Modification state
- Positive terminal polarity
- Nominal battery voltage and number of cells
- Rated capacity
- Safety instructions - where applicable

If the box is damaged from shipping, unpack the battery to inspect for any damage. If damage to the battery is found, contact the shipper immediately.

If the battery is received 4 months or longer after the latest charge, unpack the battery to perform a voltage check in accordance with paragraph 9.

8. COMMISSIONING PROCEDURES & INITIAL TESTING AFTER STORAGE

(Refer to Battery Commissioning Flowchart Appendix B)

Warning!

Short circuit currents will exceed 2000 amps; all tools must be insulated. Care must be taken with all items of metal in clothing and jewellery, e.g. buckles, zips, rings, watches, chains etc.

Caution!

Always ensure that the battery lid is securely fitted prior to charging.
Monobloc terminal nuts are NOT to be re-tightened.

Note!

1. *A dedicated lead acid battery room is not required for servicing. A normal electrical workshop may be used and under certain conditions the battery can be serviced in a nickel cadmium battery room providing an appropriate risk assessment is performed.*
2. *Use a calibrated digitial voltmeter with a DCV accuracy of 0.3%, to carry out Open Circuit voltage (OCV) checks.*
3. *All discharges must be in accordance with the rates detailed in Figure 5. Discharges should be discontinued as soon as a duration of 48 minutes or an end point of 20V is achieved (see section 12). This prevents excessive working of the battery and prolongs its life.*

8.1 VISUAL INSPECTION

Visually inspect the exterior of the battery and receptacle for signs of damage, cracks or corrosion. If any defects are found, pack the battery in its original packaging and reject the battery in accordance with paragraph 13.

8.2 VOLTAGE CHECKS

8.2.1 Measure the open circuit voltage (OCV).

8.2.2 If the open circuit voltage is in excess of or equal to 25.5 volts, the capacity is at least 80% and the battery can be issued for service.

8.2.3 If the OCV is greater than 25.3 volts but lower than 25.5 volts the battery needs to be charged.

8.2.3.1 Charge the battery in accordance with procedure defined in paragraph 9.

8.2.3.2 On completion of the recharge, allow the battery to stand open circuit for a minimum of 4 hours.

8.2.3.3 If the OCV equals 25.5 volts or greater the battery can be issued for service.

8.2.4 If the OCV is equal to or less than 25.3 volts but greater than 20.0 volts, the battery needs to be charged.

8.2.4.1 Charge the battery in accordance with paragraph 9.

8.2.4.2 On completion of the recharge, allow the battery to stand open circuit for a minimum of 4 hours.

8.2.4.3 Perform a capacity test, in accordance with paragraph 12.

8.2.4.4 If the battery fails to achieve 80% capacity (48 minutes) after charging and a capacity test, it can be recharged and tested a second time.

8.2.4.5 If the battery achieves at least 80% capacity.

8.2.4.5.1 Record the capacity and date of test.

8.2.4.5.2 Charge the battery in accordance with paragraph 9.

8.2.4.5.3 Issue the battery to service.

8.2.4.6 If the capacity fails to achieve 80% capacity after two (2) charges and capacity tests, reject the battery as per section 13.

8.2.5 If the battery is less than 20 volts then it is considered to be in a deep discharge state and must be treated in accordance with paragraph 14.

9. CHARGING PROCEDURE

This manual only covers Constant voltage (CV) charging because CV charging is the preferred method. Every effort should be made to charge Hawker® VRLA AGM batteries with constant voltage. If constant current charging is the only available option, please contact EnerSys Technical Support for guidance.

Charging should be performed in the battery work shop where the ambient temperature is maintained between 20ºC and 30ºC. The battery/re-blocking kit can be charged outside this temperature window if a temperature compensated charger is used.

Charge the battery / re-blocking kit at a constant voltage of 29.0 volts for an assembled 24V battery or 14.5 volts for individual monoblocs with a charger capable of delivering a minimum of 10 amps. Charge time depends on the rated capacity of the battery and the maximum current available from the charger.

The higher the available current the faster the battery will recharge, typical duration values are shown in Figure 4.

Figure 4 - Constant Potential Charging Times

Battery Capacity	Charge Duration (hours)		
	@ 10 A	@ 20 A	@ 30 A
18 ampere-hour	4	3	2
25 ampere-hour	6	5	4
37 ampere-hour	8	7	6
40 ampere-hour	8	7	6

10. ROUTINE MAINTENANCE

(Refer to Battery Maintenance Flowchart Appendix C)

10.1 Visually inspect the exterior of the battery casing for signs of damage and cracks. Examine the battery terminal for signs of damage, corrosion, and water/dirt ingress; clean as necessary. Always ensure that the battery lid is securely fitted prior to charging.

10.2 Measure and record the OCV using a calibrated digital multi-meter.

10.2.1 If the OCV measures greater than 25.5 volts, test the battery in the “as found” condition and continue with step 10.3.

10.2.2 If the OCV measures greater than 20.0 volts but less than 25.5 volts, charge the battery per Section 9.0 and continue with step 10.3.

10.2.3 If the OCV measures 20.0 volts or less refer to deep discharge decovery document number 9602-6298 (which is available from EnerSys Technical Support), as the battery is considered to be in a deeply discharged state.

10.3 Perform a capacity test per Section 12.

10.3.1 If the result of the capacity test is greater than 80% (48 minutes), continue with step 10.4.

10.3.2 If the result of the capacity test is 80% or less, recharge battery per section 9.

10.3.2.1 Repeat the capacity test as per section 12.

10.3.2.1.1 If the battery fails to make 80% capacity after two (2) capacity tests reject the battery per Section 13.

10.3.2.1.2 If the result of the second capacity test is greater than 80% continue with step 10.4.

10.4 Record the capacity and date of test on the battery label.

10.5 Recharge battery per section 9.

10.6 Ensure the battery is clean and return the battery to service.

11. SERVICE PERIOD

The servicing period varies with aircraft type and application. However, the earliest servicing requirement will be 6 months after commissioning unless otherwise directed by the aircraft operators and / or regulatory bodies.

At the appropriate service point remove the battery from its installation to the battery test room.

12. CAPACITY TEST

Capacity testing is performed by discharging the battery with a constant current load at the one-hour rate and measuring the time required (in minutes) to reach the cut off voltage.

Discharge the battery at the appropriate constant current value found in Figure 5 at 20 ± 2°C to an end voltage of 20 volts or 48 minutes whichever occurs first. Record the terminal voltage at the end of the discharge.

Figure 5 - Discharge Rates

Battery Rating	Discharge current
18 ampere-hour	18 amps
25 ampere-hour	25 amps
37 ampere-hour	37 amps
40 ampere-hour	40 amps

Note! *Discharge duration should not be allowed to exceed 48 minutes*

If the discharge duration of 48 minutes is achieved, recharge the battery as detailed in paragraph 9. Record the test result on the battery label and return to service.

If the discharge duration is less than 48 minutes, recharge the battery in accordance with paragraph 9. Allow the battery to stand open circuit for a minimum of 4 hours before conducting a second capacity test.

If the discharge duration is in excess of 48 minutes, recharge the battery in accordance with paragraph 9. Record the test result on the battery label and return to service.

If this second discharge duration is still below 48 minutes the battery should be rejected in accordance with paragraph 13 of this maintenance manual.

13. REJECTION PROCEDURE

If a defect has been noticed during the visual inspection stage of commissioning, quarantine the battery in its original packaging and notify EnerSys of the defect.

If the battery fails to attain a 48 minute run time (80% capacity) after two discharge tests and has been in service for **more than two (2) years,** it should be considered non-serviceable. Recycle or otherwise properly dispose of the battery. Refer to section 18 for disposal options.

If the battery fails to attain a 48 minute run time (80% capacity) after two discharge tests and has been in service for **less than two (2) years,** recharge the battery in accordance with paragraph 9 and notify EnerSys or your distributor of failure.

14. DEEP DISCHARGE RECOVERY

If the battery has an OCV of less than 20 volts it is considered to have been abused. Over discharging the battery to this extent is not recommended and can cause severe damage. In the event of a battery being in a deep discharge state the deep discharge recovery procedure for aircraft batteries document number 9602-6298 (which is available from EnerSys Technical Support) must be followed.

15. UNSCHEDULED REMOVAL FROM AIRCRAFT

In normal service this battery should not need to be removed from the aircraft between service intervals. If the battery has been removed prior to a schedule service refer to the routine maintenance procedure as detailed in paragraph 10.

16. TRANSPORTATION

Classification of transportation for Hawker® aircraft batteries are detailed in figure 6.

Figure 6

Land Transport	Land Transport (ADR/RID, U.S. DOT) - UN N°: UN2800 - Classification ADR/RID: Class 8 - Proper Shipping Name: BATTERIES, WET, NON SPILLABLE electric storage - Packing Group ADR: not assigned - Label required: Corrosive - ADR/RID: New and spent batteries are exempt from all ADR/RID (special provision 598).
Sea Transport	Sea Transport (IMDG Code) - UN N°: UN2800 - Classification: Class 8 - Proper Shipping Name: BATTERIES, WET, NON SPILLABLE electric storage - Packing Group: III - EmS: F-A, S-B - Label required: Corrosive - If non-spillable batteries meet the Special Provision 238, they are exempted from all IMDG codes provided that the batteries' terminals are protected against short circuits.
Air Transport	Air Transport (IATA-DGR) - UN N°: UN2800 - Classification: Class 8 - Proper Shipping Name: BATTERIES, WET, NON SPILLABLE electric storage - Packing Group: III - Label required: Corrosive - If non-spillable batteries meet the Special Provision A67, they are exempted from all IATA DGR codes provided that the batteries' terminals are protected against short circuits.

17. SPARE PARTS

Hawker® aircraft batteries consists of two 12-volt monoblocs encased in an outer case with removable lid.

The two 12 volt monoblocs can be replaced; however they must be replaced in pairs supplied by EnerSys® as part of a re-blocking kit. Lock nuts and internal battery connectors are supplied as part of the re-blocking kit and must be replaced at the same time.

Re-blocking kits can be purchased from EnerSys® or their appointed distributors, and can be installed by the purchaser (Refer to Paragraph 18).

See Appendix A for Re-blocking Kit details.

18. RE-BLOCKING PROCEDURE

Note! *Prior to re-blocking the battery, check the integrity of the battery case, lid, connector and lid seal. Renew if damaged or showing signs of deterioration.*

When re-blocking a battery ensure that the correct re-blocking kit is used. i.e. denoted by ampere-hour rating.

Warning!
Short circuit currents will exceed 2000 amps; all tools must be insulated. Care must be taken with all items of metal in clothing and jewellery, e.g. buckles, zips, rings, watches, chains etc. Failure to pay attention to this warning could result in serious injury or death. Battery and monoblocs are "live" throughout this procedure.

Follow the instructions below carefully: -
a) Ensure that all parts of the re-blocking kit are present.
b) Remove and retain the four lid screws and washers.
c) Remove and retain the lid.
d) Remove and discard the nuts, washers and metal strip laminations from the rear monobloc terminals.
e) Remove and discard the nuts and washers from the front terminals and lift off the laminations.

Note! *Do not remove the front laminations from the main battery connectors.*

f) Remove the expended monoblocs and replace with the new monoblocs.
g) Reconnect the front laminations using the nuts and washers provided in the re-blocking kit. Tighten the terminal nuts using a calibrated torque wrench set to 3.9 Nm 35 pound-force inch (lbf-in).

Note! *Over tightening the terminal nuts may result in fracturing of terminal posts.*

h) Connect the rear laminations across the back two terminal posts of the monoblocs using the nuts and washers provided in the re-blocking kit. Tighten the terminal nuts using a torque wrench set to 3.9 Nm (35 pound-force inch (lbf-in)).
i) Replace battery case lid, finger tighten all four lid screws prior to torque tightening to 1.0 Nm (9 pound-force inch (lbf-in)).

Note! *Over tightening of the screws will cause cracking of the battery case around the screw location holes.*

19. BATTERY RECORD CARD

A battery record card must be kept for each individual battery.

This card should show as a minimum: -

i. Battery part number and serial number
ii. Date of last charge by manufacturer
iii. Date of receipt
iv. Date of commission
v. Date of installation on aircraft
vi. Date and results of periodic routine maintenance or unscheduled maintenance
vii. Date of battery returned to storage
viii. Date of any failures
ix. Date of any returns to manufacturer
x. OCV prior to any discharge

20. DISPOSAL

Dispose of the battery in accordance with local regulations. If in doubt contact:

EnerSys Newport
Stephenson Street
NEWPORT
South Wales
UK
NP19 4XJ

Tel +44 (0) 1633 590 310
Fax +44 (0) 1633 590 323

A Control of Substances Hazardous to Health statement and Instructions for the safe handling of Lead-Acid batteries are available from EnerSys® Ltd. on request.

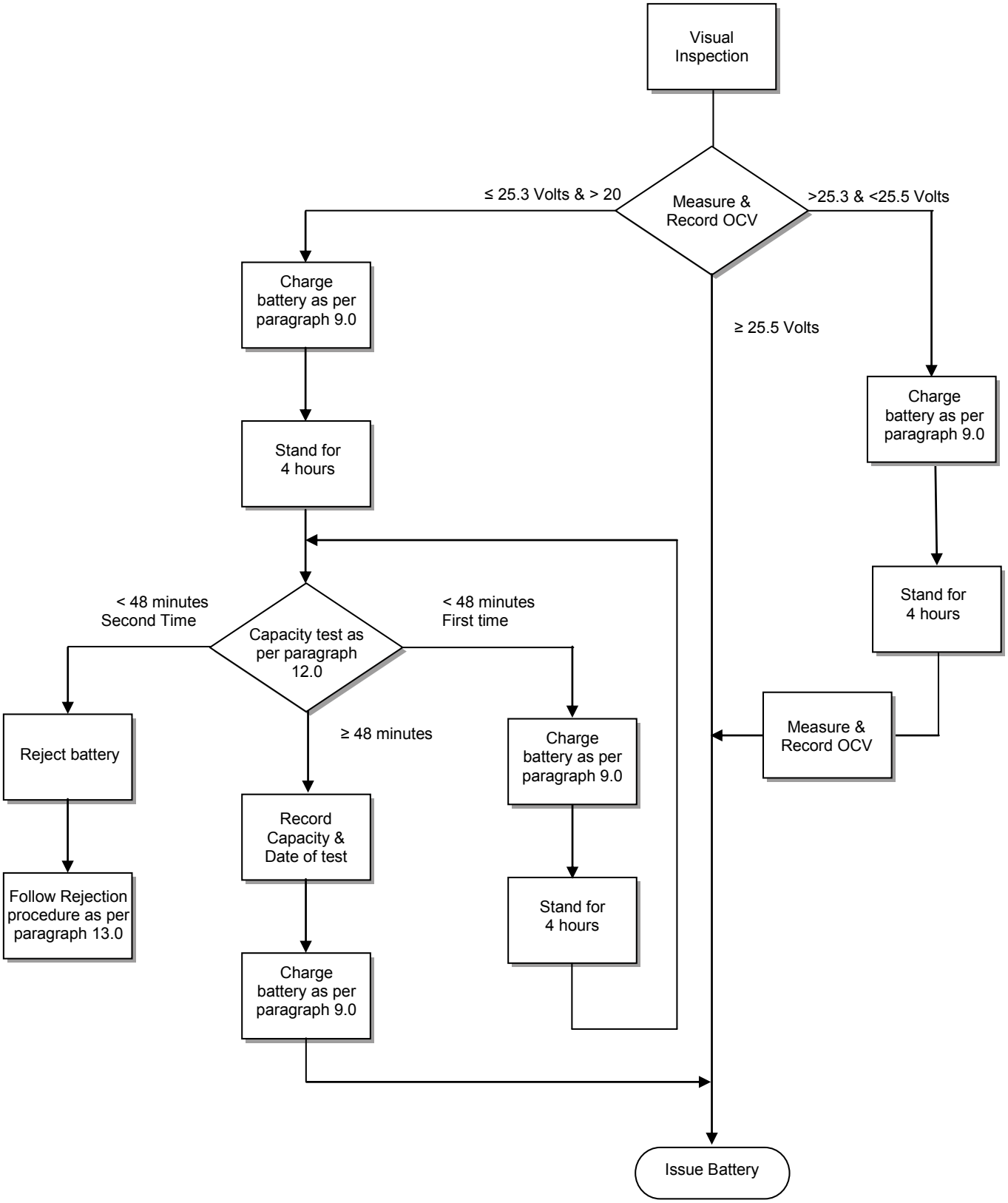
Appendix A
Battery Applicability List

This Maintenance Manual covers the following aircraft batteries

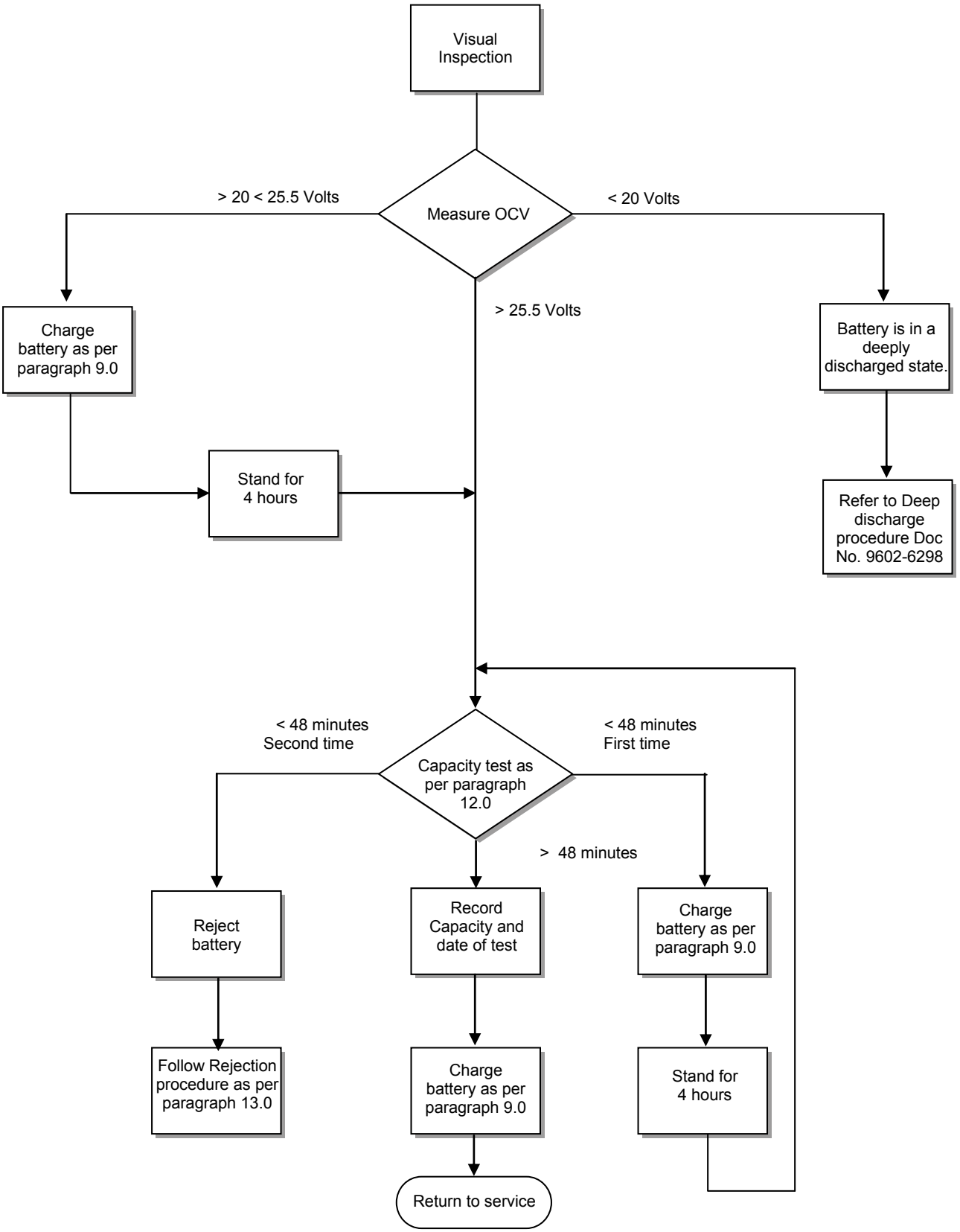
Mk.1 Product No.	Mk.2 Product No.	Capacity Ah C_1	Terminal Voltage	Connector Type	Vents	Max Weight (kg)
9750F0530		37Ah	24V	Elcon	None	38.0
9750F0531		37Ah	24V	Elcon	2	38.0
9750F0532		37Ah	24V	Canon	None	38.0
9750F0533		37Ah	24V	Canon	2	38.0
9750F0538*		37Ah	24V	Elcon	2	38.0
9750F0539		37Ah	24V	Elcon	2	38.0
9750F0540		37Ah	24V	Canon	2	38.0
9750F0542*		37Ah	24V	Elcon	2	38.0
9750F0544		37Ah	24V	Elcon	None	38.0
9750E0640	9750E0654	25Ah	24V	Elcon	None	27.0
9750E0645		25Ah	24V	Elcon	1	27.0
9750E0647	9750E0652	25Ah	24V	Elcon	1	27.0
9750E0650		25Ah	24V	Spade	None	27.0
9750E0658		25Ah	24V	Canon	1	27.0
9750E0660		25Ah	24V	Canon	None	27.0
9750E0750		25Ah	24V	Elcon	1	27.0
9750E0751	9750E0653	25Ah	24V	Elcon	1	27.0
9750D0730		18Ah	24V	Elcon	None	19.0
9750D0734		18Ah	24V	Spade	None	19.0
9750D0736		18Ah	24V	Spade	None	19.0
9750D0738		18Ah	24V	Canon	None	19.0
9750D0740		18Ah	24V	Canon	2	19.0
9750D0741	9750D0722	18Ah	24V	Canon	2	19.0
9750D0742		18Ah	24V	Elcon	2	19.0
9750D0744		18Ah	24V	Spade	2	19.0
9750D0745		18Ah	24V	Spade	2	19.0
9250-0090		18Ah	18.0			
9250-0083		25Ah	25.0			

**Cessna Caravan*

Appendix B
Battery Commissioning Flowchart



Appendix C
Battery Maintenance Flowchart



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HAWKER

Global Support

EnerSys is the world's largest industrial battery manufacturer and we are dedicated to being the best. Our strategically located manufacturing plants are efficient and responsive with a culture of continuous improvement and added value for our business partners.

EnerSys has an enviable position in technology leadership and with significant investment in research and development we intend to stay at the leading edge in product innovation. Our team of development engineers is driven by the desire to build the best energy solutions and works closely with our customers and suppliers to identify development opportunities. Our bias for rapid innovation means we get new products to the market fast.

EnerSys is dedicated to providing customers with the best solutions and after-sales support for their business, wherever you do business, EnerSys can support your requirements through our vast network of approved maintenance distributors.

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