HAWKER

Nickel – Cadmium Batteries

Operating and Maintenance Manual

UK

EnerSys®
Power/Full Solutions
AEROSPACE

Nickel – Cadmium Airborne Batteries
Operating and Maintenance Manual

HISTORY OF REVISION

This manual replaces the issues:

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Date	Modification	Version

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Index of Revision: 01

Name of the Manufacturer: HAWKER GmbH, Dieckstrasse 42, 58089 Hagen

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. 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

Contents

Abbreviations

AC	Alternating Current
CHC's	Chlorinated hyro-carbons
DC	Direct Current
DDP	Declaration of Design and Performance
EPV	End point voltage
I	Current
I-Charge	Constant current charge
IPL	Illustrated parts list
IU-charge	Constant voltage charge with a current limitation
IUI-Charge	Combination of constant voltage and constant current charge with two current limitations
MSDS	Material Safety Data Sheet
Ni/Cd	Nickel/Cadmium
OCV	Open circuit voltage
P/N	Part number
P	Power
PPE	Personal Protective Equipment
R	Resistance
S/N	Serial number
T	Task = Maintenance Task
TOCV	Top of charge voltage
TR	Technical Requirement
U	Voltage
NCC	Normally closed contact (type of thermostat)
NOC	Normally opened contact (type of thermostat)

Units

h / hrs	Hour / Hours
min	Minutes
A	Ampere
Ah	Amperehour
CA	Rated Current
CAh	Rated Capacity
V	Volt
Ω	Ohm
M	MegOhm
W	Watt
°C	°C (temperature)
°F	°Fahrenheit (temperature)
bar	bar
kPA	kiloPascal
Nm	Newtonmeter
g	Gram
l	Litre
kg/l	Kilogram per Litre (density)

1. Maintenance Manual for the HAWKER® Ni/Cd Airborne Battery – Purpose and Use

The manual describes the processes for trained technicians to maintain Hawker® nickel-cadmium airborne batteries. It informs about their basic design features and details structured tasks for visual inspection, diagnostic, testing, performance reconditioning, repair and the necessary care to maintain best endurance and useful life of these batteries.

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

1.1. Applications of Ni/Cd aircraft batteries

HAWKER® airborne batteries are used for:

- starting engines or APUs,
- operations on ground and in flight
- emergency back up.

1.2 Features and designation of the battery

1.2.1. THE BATTERY

The 24V battery is made up of 20 cells connected in series, which are assembled in a battery case. The battery container and the lid are typically made of stainless steel. Some battery types have a container of stainless steel and a lid of polymer material. The interior container walls are lined with heat resistant plastic plates. The lid is lined with a ribbing, which acts as a pressure pad for the cells. The electrical connector typically is mounted on the front of the battery container; but on some battery types the electrical connector is mounted at the side. It enables electrical connection of the battery to the power supply system. All batteries can be additionally fitted with heater and temperature sensors or temperature sensors only.

Figure one: Batteries

Elements of the Battery designation:

The Hawker® aircraft battery designations consist of the following elements

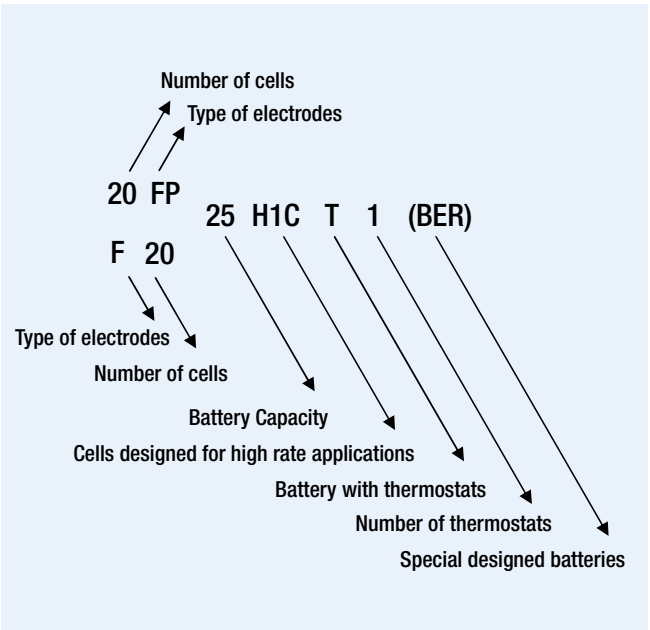
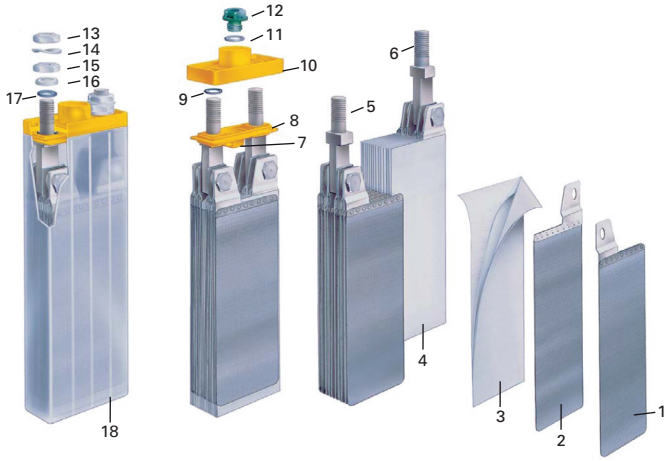


Figure two: The cell



1 negative electrode
2 positive electrode
3 separator
4 plate stack
5 negative pole terminal
6 positive pole terminal
7 electrolyte level indicator
8 spacer
9 seal
10 lid
11 seal (vent)
12 vent (plug)
13 upper terminal nut
14 springwasher
15 lower terminal nut
16 sealing cap
17 seal
18 cell case

The cell comprises an assembly of positive (2) and negative (1) sintered electrodes, alternately arranged and meander-like separated with very thin hydrophilic layers of polymer materials (3). The plate stack (4) with the two pole terminals (5, 6) is placed in a prismatic plastic container (18) which is leak-proof welded with a cell lid (10) that has two bores for the poles and a centric threaded hole for the vent (12). The vent closes the cell house filled with alkaline electrolyte.

1.2.2.1. Positive and negative electrodes

The positive and negative electrodes are made of a sintered metallic structure containing electrochemically active masses in its pores. The metallic tabs welded to the electrodes are acting as current collectors.

1.2.2.2 Separators

Three layers of oxidations-resistant separator made of non-degradable synthetic materials separate the positive and negative electrodes, arranged alternately. The outer layers are of nonwoven fabric, whereas the inner layer is a very thin hydrophilic polymer film. The film acts as a gas barrier that is reducing the exothermic oxygen recombination during charge and thus ensures excellent charge stability of the cells.

1.2.2.3 Electrolyte

The electrolyte is a solution of potassium hydroxide in deionised water with a typical density of 1.28 ± 0.02 kg/l at 20°C.

1.2.2.4 Vent plugs

The cell vents release the gas generated during float charge, whilst also preventing electrolyte leakage and contamination of electrolyte.

1.2.2.5 Pole terminals, connectors and terminal nuts

Pole terminals, nuts and connectors used for the inter-cell connection are made of highly conductive nickel-plated copper material.

1.3 Basic electrochemical reactions in cells

Positive Electrode = Nickel hydroxide – electrode

Negative Electrode = Cadmium/Cadmiumhydroxide – electrode

POSITIVE ELECTRODE	NEGITIVE ELECTRODE		POSITIVE ELECTRODE	NEGITIVE ELECTRODE
$2Ni(OH)_2$	+ $Cd(OH)_2$	CHARGE ⇄ DISCHARGE	$2NiO(OH)$	+ $Cd+2H_2O$

Due to the very small changes in density by charge and discharge operation, the density of the electrolyte cannot indicate cell's state of charge.

1.3.1 CONVERSION OF ENERGY

During charging, the active masses of the electrodes convert electrical energy into chemical energy. The discharge process reaction reverses it.

1.3.2 ELECTROLYSIS AND EVOLUTION OF GAS DURING OVERCHARGE AND REVERSAL CHARGE

During overcharge, the water of the electrolyte is decomposed. The hydrogen generated at the negative Cadmium electrodes and oxygen generated at the positive Nickelhydroxide electrodes escape through the vent of the cell.

$$2\,H2O \longrightarrow 2H2 + O2$$

1.3.3 OXYGEN RECOMBINATION BY INTERNAL ELECTROCHEMICAL REDUCTION ON ELECTROLYTE-WET LIVE PARTS

A part of the oxygen generated, reduces according to the two side reactions below. According to 1.3.2, the reduced oxygen is equivalent to an amount of hydrogen that is not generated. In total, the recombination of oxygen suppresses the decomposition of water, but it heats the cells.

$$O_2 + 2\,H_2O + 4e^- \longrightarrow 4\,OH^- + Heat$$

Chemical reduction of oxygen at electrolyte-wetted Cadmium during normal overcharge.

$$2\,Cd + O_2 + 2\,H_2O \longrightarrow 2\,Cd(OH)_2 + Heat$$

1.4 Specified definitions

1.4.1 CURRENT RATES

The current rates express values of current in ampere (A) used to charge and discharge cells and batteries as a multiple of its (nominal) current. For example, a current of 20 A used to charge a cell with a rated capacity of 100 Ah would be expressed as $C_5 = 0.2{*}I_1$ or $0.2\ C_1 = 0.2{*}I_1$.

1.4.2 RATED CURRENT (I_1)

The rated discharge current of the battery returns not less than its rated C_1 capacity in 1 hour.

1.4.3 RATED CAPACITY C_1

The rated capacity is the minimum capacity, expressed in Ah, obtained from a charged battery when discharged at the I_1 rate to the EPV.

1.4.4 CONSTANT VOLTAGE CURRENT I_{PR}

The I_{pr} is the discharge current, which the battery delivers at the conclusion of a 15sec power discharge, controlled as maintained a constant voltage of half the nominal battery voltage.

1.4.5 EPV = END POINT VOLTAGE OF THE BATTERY

Unless otherwise stated during discharge the EPV of the battery corresponds roughly to 1 Volt * number of cells.

1.5 Commonly used terms

1.5.1 CONSTANT (LOW) CURRENT CHARGING (APPENDIX 2)

The constant current charging is a method used to charge a fully discharged battery with a predefined current and duration. The recommended rates for charge are $0.2{*}I_1$ for 7 hours, or $0.1{*}I_1$ for 14 hours. For the commissioning and reconditioning of cells 8 hours at $0.2{*}I_1$ is strongly recommended.

1.5.2 IUI CHARGING – (FAST CHARGING IN ACCORDANCE WITH APPENDIX 1)

The IUI-charge recommended in this manual is a general method for recharging the batteries from an unknown state of charge. It shall not be applied at battery temperatures below 0°C and on batteries stored inactive for more than 3 month.

1.5.3 END OF CHARGE VOLTAGE

The end of charge voltage is the voltage of a battery or cell prior to the charge current being switched off.

1.5.4 CONSTANT VOLTAGE CHARGING

Constant voltage charges (e.g. at 1.425 Volt per cell) shall not be used to maintain and recondition the cells of batteries as the overcharge at constant current (section 1.5.1) is more efficient to condition cells imbalanced from cyclic services with constant voltage charges and shallow discharges.

1.5.5 CAPACITY TEST

A capacity test is the measurement of the discharge time and the discharge voltage at a constant discharge current until the defined EPV is met. The product of discharge time and discharge current calculates the capacity.

1.5.6 OPEN CIRCUIT VOLTAGE

The open circuit voltage is the voltage of the battery, without being connected to any units that can provide or consume electrical power.

1.5.7 DEEP DISCHARGE

The deep discharge is a part of the maintenance process “Reconditioning” to recover reversible losses of battery capacity and discharge voltages, which might have been created in service.

1.5.8 RECONDITIONING

Reconditioning is a process to recover reversible capacity losses on cells imbalanced during shallow cycling and discharge voltage reduction by continuous float charge, or storage.

1.5.9 CAPACITY REDUCTION WHILE THE BATTERY IS IN SERVICE

The battery capacity can reduce, if the on board charging voltage is too low. This capacity reduction can be reversed by battery maintenance.

1.5.10 AGEING AND LOSS OF PERFORMANCE

Ageing causes battery’s irreversible losses of energy conversion. These losses cannot be cured by electrical treatments. One effect of cell’s ageing is the accumulation of impurities, and of corrosion products in the electrolyte and the electrodes of the cells. Any removal of such effects, by undefined measures is inadmissible.

1.5.11 AIRWORTHINESS

Airworthiness is the compliance of battery component(s) with all conditions and regulations required by the approving authorities for their safe operation and performance.

1.5.12 END OF LIFE CAPACITY.

The end of life capacity of maintained cells is defined as ≤80% of the rated capacity (compare section 1.4.3)

1.6 Technical data

1.6.1 OPERATIONAL PARAMETERS

- Operational temperature range limited from -50°C to 71°C;
- Continuous voltage controlled charges procedures should not be performed above 60°C (battery temperature)
- Due to potential risk of any ice formation in the electrolyte of the cells should not be charged below -30°C (battery electrolyte temperature)
- For any specific technical data refer to the relevant DDP (Declaration of Design and Performance) or Technical Specification which can be requested from the authorised Hawker® representative.

1.6.2 TECHNICAL CELL DATA, TABLE 1

Cell designation	FP44H1C	FP40H1C	FP38H1C	FP27H1C	FP25H1C	FP22H1C	FP17H1C	FP7H1C	FP4H1C
Rated voltage. (V)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Electrolyte – density	Potassium hydroxide solution, density at 20°C: 1.28 kg/l ± 0.02 kg/l								
Thread of upper pole nut	M10	M10	M10	M10	M8	M8	M8	M8	M4
Torque of: lower pole nut Torque of upper pole nut	7 Nm (70 kpcm) 10 Nm (100 kpcm)				4 Nm (40 kpcm) 5 Nm (50 kpcm)				0.9 Nm (9 kpcm) 1.6 Nm (16 kpcm)
Venting pressure	Green vents 0.35 ± 0.2 bar;								
Venting pressure	Blue vents: 0.4 to 0.7 bar								

1.6.3 TECHNICAL BATTERY DATA: TABLE 2

Battery type	Type No.	SAP No*	Cell type	Nominal voltage (V)	Rated capacity (Ah)	Ipr(A) to 25°C	Length (mm)	Width (mm)	Height (mm)	Typ. Weight kg)
F20/4H1C-R	3349004 910	2314772	FP4H1C	24	4	150	166	118	109	4.5
F20/7H1C-E2	3349007 9000	2314845	FP07H1C	24	7	450	325	180	130	13.0
F20/15H1C	3349015 910	2314918	FP15H1C	24	15	600	198	195	196	16,7
F20/17H1C	3349017 910	2315047	FP17H1C	24	17	700	198	195	196	16.9
F20/17H1CT	3349017 960	2315096		24	17	700	198	195	196	17.1
F20/17H1C-1	3349017 920	2315055		24	17	700	253	158	188	16.9
F20/17H1CT2-1	3349017 900	2315039		24	17	700	253	158	188	17.2
F20/17H1C-2	3349017 930	2315063		24	17	700	260	147	188	17.0
F20/17H1CT-2	3349017 950	2315088		24	17	700	260	147	188	17.1
F20/17H1C-3	3349017 940	2315071		24	17	700	321	125	200	17.3
F20/22H1C-1	3349022 900	2315144	FP22H1C	24	22	900	424	119	180	23.5
F20/25H1C	3349025 900	2315274	FP25H1C	24	25	1025	254	197	223.5	25.5
F20/25H1CT	3349025 910	2315322		24	25	1025	254	197	223.5	25.6
F20/25H1C-L39	3349025 990	2315444		24	25	1025	402	207	250	28.5
F20/25H1CT2	3349025 920	2315355		24	25	1025	254	197	223.5	25.7
20FP25H1C-R	3349025 940	2315371		24	25	1025	363	174	226	24.5
20FP25H1CT-R	3349025 950	2315396		24	25	1025	363	174	226	24.5
F20/27H1C	3349027 920	2315622	FP27H1C	24	27	1125	254	248	204	27.5
F20/27H1CT	3349027 910	2315599		24	27	1125	254	248	204	27.6
F20/27H1C-T2	3349027 940	2315647		24	27	1125	254	248	204	27.7
F20/27H1C-E1	3349027 900	2315582		24	27	1125	363	168.5	218	28
F20/27H1C-M1	3349027 9600	2315703		24	27	1125	478.5	168.5	237.5	28.6
F20/27H1C-M1T	3349027 7000	2315509		24	27	1125	478.5	168.5	237.5	28.7
F20/27H1C-M3	3349027 8000	2315574		24	27	1125	478.5	168	218.5	29.4
20-FP38H1C-R	3349038 900	2315752	FP38H1C	24	38	1350	495	174	226	34.9
20FP38H1CT-R	3349038 901	2315769		24	38	1350	495	174	226	35.0
20FP38H1CT-R	3349038 9011	2315785		24	38	1350	495	174	226	35.0
20FP38H1CT2-R	3349038 9010	2315777		24	38	1350	495	174	226	35.1
F11/40H1C	3349040 100	2315793	FP40H1C	13.2	40	1500	223.5	182.5	253.5	21.7
F20/40H1C	3349040 910	2315914	FP40H1C	24	40	1500	254	248	262	36.4
F20/40H1CT	3349040 9206	2316002		24	40	1500	254	248	262	36.5
F20/40H1CT2(P)	3349040 9201	2315955		24	40	1500	254	248	262	36,6
F20/40H1C-AC	3349040 960	2316092		24	40	1500	254	248	262	36.5
F20/40H1C-E1	3349040 900	2315882		24	40	1500	363	168.5	268	38.5
F20/40H1CT/A	3349040 9200	2315947		24	40	1500	254	248	262	37.6
F20/40H1CT3	3349040 9209	2316035		24	40	1500	254	248	262	36.7
F20/44H1C	3349045 910	2316181	FP44H1C	24	44	1500	254	248	262	37,4
F20/44H1CT	3349045 920	2316198		24	44	1550	254	248	262	37.5

2. Safety measures and instructions

2.1 Safety Instructions, Warnings and Notes

“CAUTION” is necessary, if non-adherence or incorrect adherence to the service or working instructions could cause injuries or fatal accidents.

“ATTENTION” applies, if non-adherence or incorrect adherence to the service or working instructions might cause damage to the unit and potential safety issues.

“NOTE” draws attention to important points.

2.2 General safety instructions:

- Observe the (local) instructions for battery use and position them visibly near the battery
- Trained personnel must only carry out work on batteries
- Read the Material Safety data sheet.

- 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.

- Avoid any contact of electrolyte with the eyes, open wounds / skin and clothing
- Avoid ingestion of electrolyte. In case of skin contact with electrolyte and/ or ingestion of electrolyte as well as burns consult a doctor immediately or “First Aid”, flush skin and eyes with plenty of water or a solution of boric acid in water,

- Remove electrolyte contaminated clothes, immediately wash in excess of acetic water
- The potassium hydroxide electrolyte solution is highly corrosive.
- Avoid any spilling of electrolyte
- Do not disassemble cells since cadmium and cadmium oxide is poisonous and is believed to be carcinogenic. Nickel can cause serious skin allergic reactions and skin irritations to nickel sensitive and exposed persons.

- Batteries are heavy.
- Use suitable transportation / lifting equipment
- Battery vent tubes are not intended for use as lifting handles.

- Risks of explosion and fire
- Do not use any inflammable organic solvents, CHC’s and mixtures of it for cleaning
- Do not dismantle cells
- Avoid conditions for electrical shocks by using insulated tooling. Electrical short circuits and sparks may injure the operator, damage the battery and ignite gases from charging
- Do not wear clothes with static fibres and metallic accessories (rings, watches, belts jewellery) when working on batteries. Use a plastic brush and antistatic cleaning cloth for dry wiping off adhesive dirt from the battery
- Never place any conductive parts on metallic parts of the battery
- Do not block the battery outlet pipes with the liners
- Remove battery lid from container prior to charging.

- Pay attention to the hazards that can be caused by batteries.

3. Commissioning of new batteries

3.1 Log book

The operator shall record and confirm by signature in the log book the process steps and data measured on the battery and its cells. These records are required to provide evidence of the airworthiness of the battery. Failures to comply with this instruction may invalidate the warranty conditions.

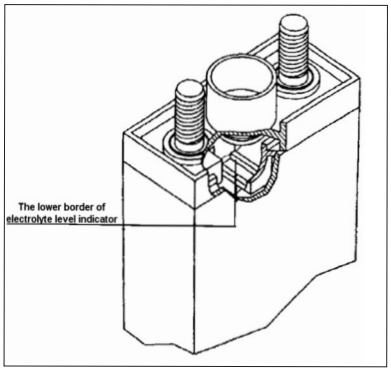
3.2 Goods inwards inspection Task for new batteries

Task 3.1 – Goods inwards inspection of a new battery on receipt	
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Visually check the delivered packing boxes with batteries for signs of transportation and thermal damage as well as for moisture.	
2. Unpack the boxes and check the delivery is complete according to the accompanied documentation.	Contact the supplier.
3. Visually inspect the battery internally and externally for signs of impact damage, corrosion and leakage.	Record the findings into the log book Any defects quarantine the battery and contact the supplier.
4. For any additional goods inwards inspection refer to the local regulations.	Record the findings into the log book.
5. Record the results in the battery log book.	

3.3 Commissioning Task 3.2 for new batteries

Task 3.2 – Commissioning of new batteries	
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION **Never charge, discharge or adjust electrolyte on cells connected in series outside the battery case.** 1. Remove the lid from the battery case.	
2. Remove the caps from the main connector pins using insulated tools	Contact the supplier
3. Tighten the upper pole nuts with the correct torque as indicated in Table 1 of section 1.6.2	Record the findings into the log book. Any defects quarantine the battery and contact the supplier.
4. Measure the insulation resistance with a MΩ-meter at 250 V DC between the + pin of the battery connector and the battery case and the insulation resistances with same device at 250 V DC between the + terminal of each cell and the battery case.	If R ≤ 10 MΩ due to moisture, remove the lid and store the battery for 24 hours in an air-conditioned room and repeat the test. In case of failure: return the new battery to the supplier.
5. Undo the vents and keep them aside on the cells mouth. **ATTENTION** **Do not top up the discharged cells at this stage**	
ATTENTION: • **Do not use mercury thermometer.** • **Place none-insulated thermocouple probes between the cells.** 6. Install a thermometer or suitable insulated temperature probe in a cell placed at the centre of the battery. The device shall touch the separators of the plate stack.	
7. Connect the battery to the charge / discharge unit.	
8. Charge the battery for 8 hours at 0.2 I_1 as shown in Appendix 2 (commissioning charge). If necessary, adjust the electrolyte level of the cells 15 to 10 minutes prior to the end of charge. **Figure 3: adjusting electrolyte level**  **CAUTION** **Always wear protective goggles and gloves when working on the battery** **ATTENTION** **For adjusting the electrolyte level use distilled water**	

Figure 4: Electrolyte level indicator



ATTENTION

If necessary, adjust the electrolyte level to the height that touches the edge of the spacer.

ATTENTION

The electrolyte level of charged cells decreases after charge while the gas is escaping. Do not adjust electrolyte level further.

9. Stand the battery for one hour on open circuit.

10. Check the battery temperature is below 35°C

11. Ensure that the battery is connected to the charge/discharge unit.

12. Discharge the 24V Battery at I_1 to 20 V.

Requirement: The voltage of each cell after 60 minutes must be equal or greater than 1.0 V.

Note: If the discharge at the I_1 rate is not feasible, select a different set of discharge rate and criteria from the table below.

Record the cell voltages (column 3) in the log book.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	300	≥1.0
$0.4*I_1$	150	≥1.0
$0.6*I_1$	100	≥1.0
$0.8*I_1$	75	≥1.0
I_1	60	≥1.0

If any battery does not meet the requirement contact the supplier.

13. Soak the battery to room temperature for up to 8 hours before recharging.

14. Recharge the battery using a method indicated in section 14.1 or 14.2 or 14.3

- Adjust the electrolyte level at a current of $0.2*I_1$ 15 minutes to 10 minutes prior to end of the charge methods, 14.1, 14.2, and 14.3
- Afterwards measure the voltage on each cell prior to the end of charge at $0.2*I_1$.

Requirement: cell voltage shall be ≥ 1.56 V

- Record the values in the log book.

Note:

If the battery has to be charged below 0°C, apply 7 hours charge at $0.2*I_1$.

ATTENTION:

- **Do not charge the battery with currents higher than I_1**
- **If you cannot fully supervise, do not use method described in 14.3.**

14.1 IUI charge – method (Appendix 1)

- Charge the battery at I_1 until voltage has increased to 1.55V times number of cells and charge for 2 hours at $0.2*I_1$
- After about 1 hour charge, check that battery has reached the voltage level to switch the charge current to $0.2*I_1$.

14.2 I charge method (Appendix 2)

- Charge the fully discharged battery for seven hours at $0.2*I_1$.

14.3 II charge method (Appendix 3)

ATTENTION:

- **Charge the fully discharged battery with parameters selected from the table below and afterwards charge for two hours at $0.2*I_1$**
- **Check battery current switching to $0.2*I_1$ at the stage 1(max) time presented in the table below.**

current	Stage 1 time (max)
$0.4*I_1$	180
$0.6*I_1$	120
$0.8*I_1$	90

In case cells fail this requirement, contact the supplier

15. Stand the battery for 1 hour minimum and 24 hour maximum and then refit the vents on the cells and fit the lid in its correct orientation as indicated by the arrowhead which points in the direction of the main connector.

3.4 Release to aircraft Task 3.3:

For any additional specific release requirement refer to Task 3.3 below

Task 3.3 – Specific release requirements	
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Install the battery into the aircraft as described in the flight manual. NOTE This manual does not provide aircraft-specific working instructions.	
2. Carry out the pre-flight testing on ground as defined in the flight manual, if required.	If the battery fails, reject it from service and send it to workshop for maintenance.
3. Recharge the battery in the battery workshop, if more than 20% is discharged during the pre-flight tests as described in the flight manual.	If charging is not described in the flight manual, remove the lid and refresh charge battery for 7h at 1.425V per cell, with closed cell vents.

4. Maintenance Intervals

4.1 Unscheduled maintenance procedures

Following an unscheduled removal from aircraft the battery shall be taken to the battery workshop for investigation in accordance with the following steps.

- Fault Finding: refer to Section 9
- Inspection and Diagnostic: Task 10.1
- Repair: (repair the battery as necessary in accordance with Tasks below:).

Task 10.2 – replacement of upper pole nuts, spring washers and intercell links

Task 10.3 – replacement of lower pole nuts, sealing caps and seals

Task 10.4 – replacement of the thermostat switch assembly

Task 10.5 – replacement of the main battery connector

Task 10.6 – replacement of the battery case and or battery lid

Task 10.7 – replacement of the cell(s)

Task 10.8 – replacement of the insulating materials

Task 10.9 - Commissioning of repaired battery:

4.2 Scheduled maintenance procedures

4.2.1 MONTHLY CHECKS ON AIRCRAFT.

If a monthly check is specified in the flight manual, then carry out Monthly on "aircraft" check in accordance with **Task 7.1.**

4.2.2 QUARTERLY MAINTENANCE

Quarterly maintenance shall be carried out 3 months after installing the maintained battery into the aircraft. Tasks to be undertaken are listed below and shall be carried out in accordance with

Quarterly maintenance Task 7.2

Release-Inspection check Task 3.3.

4.2.3 ANNUAL MAINTENANCE

Annual maintenance overhaul shall be carried out every 12 months.

Tasks to be undertaken are listed below and shall be carried out in the presented sequence.

Annual maintenance Task 7.3

Release-Inspection check Task 3.3.

4.3 Maintenance Facility.

The maintenance on Hawker® batteries shall be carried out in a dedicated battery shop by trained technicians. Requirements for battery maintenance shops are defined in specifications.

4.4 Spare parts for repair

Any battery components used for replacing defective parts at repair shall comply with part number as identified in the battery-specific IPL. Only Hawker® approved spare parts shall be used.

4.5 Equipment, Tools and Consumables for maintenance

Hawker® recommends the use of equipment, tools (listed in Appendix 5) and consumable (listed in Appendix 6) for maintenance and repair on Hawker® batteries.

5.0 Storage Tasks for airworthy batteries

5.1 Short-term storage of charged batteries

Maintained and charged batteries can be stored for 3 months at ≤35°C in a secured area.

Refer to Task 5.1 - Storage of maintained (overhauled) charged batteries up to 3 month.

The batteries shall be stored:

- without being trickled charged
- in upright position
- with vents tightened
- with the lid locked on the battery case,
- plastic caps are mounted on both pins of the connector
- in a well-ventilated or air-conditioned room between 10°C and 35°C and a relative humidity between 45 and 75%
- protected from dust, moisture, corrosive gases and excessive heat
- in an area with authorised access, only.

Prior to installing the battery on the aircraft, it shall be recharged for 7 hours with a constant voltage of 1.425 V per cell.

After 3 months storage the battery shall be subjected to quarterly maintenance.

5.2 Long-term storage (up-to 5 years) of discharged batteries

Batteries can be stored between 3 months and 5 years only in a discharged state.

Refer to Task 5.2 for long-term storage preparation procedures.

The batteries shall be stored:

- Always in maintained and discharged condition
- in upright position
- with vents tightened
- with the lid locked on the battery case
- plastic caps are mounted on both pins of the connector
- in a well-ventilated or air-conditioned room between 10°C and 35°C and a relative humidity between 45 and 75%
- protected from dust, moisture, corrosive gases and excessive heat
- in an area with authorised access, only.

When returning the battery back into service, carry out Task 5.3 “Commissioning of prolonged stored batteries”.

Task 5.1 – Storage of maintained (overhauled) charged batteries up to 3 month

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Carry out the scheduled maintenance procedure on the battery, either Task 7.2 or Task 7.3.	
2. Store the battery in a ventilated room at temperatures recommended 10°C and 35°C and at relative humidity between 45% and 75%.	
3. If returning the battery to service within the 3 months storage time, recharge with a constant voltage of 1.425 V per cell at 20°C ± 5°C without opening the vents.	If the charged battery is stored for longer than 3 months and shall be returned to service, subject it to quarterly maintenance procedure Task 7.2.
4. If required, release the battery to service according to Task 3.3.	

Task 5.2 - Preparation for long term storage

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Carry out the scheduled maintenance procedure on the battery in accordance with Task 7.3.	
2. Discharge the battery to an average of 1V per cell using current rates between I_1 and $0.1*I_1$.	
3. Store the battery in a well-ventilated or air-conditioned room at temperatures between 10°C and 35 °C and at relative humidity between 45% and 75% up-to a maximum of 5 years.	

Task 5.3 – Commissioning of prolonged stored batteries

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Remove the lid from the battery case.	
2. Remove the caps from the main connector pins using insulated tools.	
ATTENTION: • **Do not top up the discharged cells at this stage** • **Undo the vents and keep them aside on the cells mouth.**	
ATTENTION: • **Do not use mercury thermometer** • **Place none-insulated thermocouple probes between the cells.** 3. Install a thermometer or suitable insulated temperature probe in a cell placed at the centre of the battery. Install non-insulated temperature probe between the cells.	
4. Connect the battery to the charge / discharge unit.	
5. Charge the battery for 8 hours at $0.2*I_1$ as shown in Appendix 3 (commissioning charge). If necessary, adjust the electrolyte level of the cells prior to the end of charge.	

Figure 3: adjusting electrolyte level

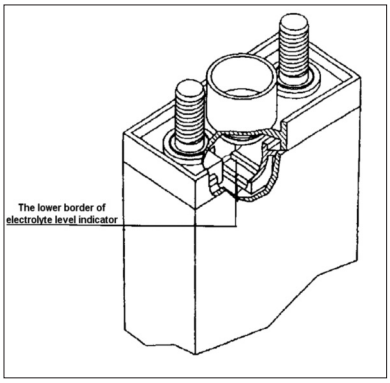
CAUTION

Always wear protective goggles and gloves when working on the battery

ATTENTION

For adjusting the electrolyte level use distilled water

Figure 4: Electrolyte level indicator



ATTENTION

If necessary, adjust the electrolyte level to the height that touches the edge of the spacer.

ATTENTION

The electrolyte level of charged cells decreases after charge while the gas is escaping. Do not adjust electrolyte level further.

6. Stand the battery for one hour.

7. Check the battery temperature is below 35°C.

   If battery temperature above, soak it to ambient room temperature.

8. Ensure that the battery is connected to the charge/ discharge unit.

9. Discharge the 24V Battery at I_1 to 20 V.

   Requirement: The voltage of each cell after 48 minutes must be equal or greater than 1.0 V.

   If any battery does not meet the requirement contact the supplier.

   Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

   Record the cell voltages (column 3) in the log book.

10. Soak the battery to room temperature for up to 8 hours before recharging.

11. Recharge the battery using a method indicated in section 12.1 or 12.2 or 12.3.

    - Adjust the electrolyte level at a current of $0.2*I_1$ 15 minutes to 10 minutes prior to end of the charge methods, 12.1, 12.2, and 12.3
    - Afterwards measure the voltage on each cell prior to the end of charge at $0.2*I_1$.

    Requirement: cell voltage shall be ≥ 1.56 V

    - Record the values in the log book.

    NOTE
    If the battery has to be charged below 0°C, apply 7 hours charge at $0.2*I_1$.

    ATTENTION:

    - **Don't charge the battery with currents higher than I_1**
    - **Do not apply method 12.3, if the battery cannot be fully supervised.**

    In case cells fail this requirement, contact the supplier.

12.1 IUI charge – method (Appendix 1)

- Charge the battery at I_1 until voltage has increased to 1.55V times number of cells and charge for 2 hours at $0.2*I_1$
- After about 1 hour charge, check that battery has reached the voltage level to switch the charge current to $0.2*I_1$.

12.2 I charge method (Appendix 2)

- Charge the fully discharged battery for seven hours at $0.2*I_1$.

12.3 II charge method (Appendix 3)

- Charge the fully discharged battery with parameters selected from the table below and afterwards charge for two hours at $0.2*I_1$
- Check battery current switching to $0.2*I_1$ at the stage 1(max) time presented in the table below.

current	Stage 1 time (max)
$0.4*I_1$	180
$0.6*I_1$	120
$0.8*I_1$	90

13. Stand the battery between 1 hour and 24 h (maximum) and then refit the vent.

14. Fit the lid onto the case.

15. Release the battery to service, if required in accordance with Task 3.3.

6. Transportation of batteries

Refer to Task 6.1 below: Shipment of batteries

Task 6.1 – Shipment of batteries	
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Discharge the battery to 1 Volt per cell using currents between I_1 and $0.1*I_1$.to an end point of 1 V times number of cells.	
2. Ensure that the vents are tightened.	
3. Protect the main connector pins with the plastic caps against short circuit.	
4. Refit the lid.	
NOTE Ensure the battery log book is shipped with the battery 5. Pack the battery in upright conditions and according to the local instructions.	
6. Ship the battery in accordance with the appropriate national hazardous goods regulations for flooded Ni/Cd batteries.	

7. Maintenance Tasks

Task 7.1 – Monthly on "aircraft" check

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
Note: The battery can be inspected visually fitted in the aircraft or alternatively removed and inspected on the airfield. **ATTENTION** **Do not disconnect a battery whilst under load.** 1. Remove the lid from the battery case.	Check the locks for defects, if the lid cannot be removed.
2. Check whether the interior battery is contaminated with electrolyte.	Send battery to workshop.
3. Check the battery case and lid as well as connectors, pole nuts, temperature sensor assembly for any mechanical and thermal damages, as well as any signs of dents, cracks, splits, overheating, short circuits, melting, burn down, dark spots and tarnish.	Any damage found, send battery to workshop.
4. Inspect the main connector for any damage caused by arcing, faulty connection, corrosion, loose parts, cracks in the connector casing.	Any damage found, send battery to workshop.
5. Inspect harnesses, temperature switches, thermistors and thermocouples for loose wiring, cracks, dents, connector pins in place.	Any damage found, send battery to workshop.
6. Record in the battery log book whether the battery has passed or failed.	
7. Refit the lid on the battery case after the check.	

Task 7.2 – Quarterly maintenance of airborne batteries

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Remove the lid and check that the gasket is fully adhered to the lid.	Any damage found, record defect and replace in accordance with the Repair Task 10.6.
2. Inspect battery container and lid for any damages, signs of dents, cracks, splits, overheating, short circuits, melting, dark spots and tarnish.	Any damage found, record defect and replace in accordance with Repair Task 10.6.
3. Inspect the main connector for signs of damage caused by arcing, faulty connection, corrosion, loose parts and cracks in the connector casing.	Any damage found, record defect and replace in accordance with Repair Task 10.5.
CAUTION: **Mineral salts from spilled electrolyte are caustic. When cleaning batteries and cells wear goggles and gloves; in addition wear dust mask and ear protection when applying compressed air for cleaning; the compressed air shall have a pressure below 3 bar.** 4. Tighten any loose vent plugs and clean the top of the cells with a plastic brush, and remove any remaining deposits with an oil-free compressed air.	

5. Tighten and torque the upper nuts as detailed in section 1.6.2, table 1

6. Inspect visually harnesses with temperature switches, thermistors, thermocouples, and for loose wiring, cracks, dents, connector pins in place and any damages.

Any damage found, record defect and replace in accordance with Repair Task 10.4.

7. Measure the insulation resistance with a MΩ-meter at 250 V DC between the + pin of the battery connector and the battery case.

   Requirement: ≥0.5MΩ

If **R ≤ 0.5 MΩ**, continue at Task 7.3 step 12 (Annual maintenance).

8. Measure and record cell voltages.

9. Mark cells with voltages lower than 1.2V (as possible defective cells).

10. Undo the vents and keep them aside on the cells mouth.

    ATTENTION
    Do not top up the cells with water at this stage.

11. Connect the battery to the charge / discharge unit.

ATTENTION
Do not use mercury thermometer.

Soak the battery to ambient room temperature,

12. Check the battery temperature; Requirement: below 35°C.

13. Discharge the 24 V battery at I_1 to 20 V. (pay particular attention to previously marked cell(s) in step 8/9).

Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1.0V.

Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table 7 below.

If the requirement is not met, then continue with Task 8.1, “Reconditioning.”

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

Record the cell voltages at the corresponding time indicated in column 2 in the log book.

14. Soak the battery to room temperature for up to 8 hours before recharging.

15. Recharge the battery using either 15.1, or 15.2 or 15.3

- Adjust the electrolyte level at a current of $0.2*I_1$ 15 minutes to 10 minutes prior to end of the charge methods, 15.1, 15.2, and 15.3.
- Afterwards measure the voltage on each cell prior to the end of charge at $0.2*I_1$.

Requirement: cell voltage shall be ≥ 1.56 V

- Record cells end of charge voltages in the logbook.

ATTENTION:

- **Do not charge the battery with currents higher than I_1**
- **If you cannot fully supervise, do not use method described in 15.3.**

15.1 IUI-charge = IUI charge – method Appendix 1)

- Charge the battery at I_1 until voltage has increased to 1.55V times number of cells and charge for 2 hours at $0.2*I_1$
- After about 1 hour charge, check that battery has reached the voltage level to switch the charge current to $0.2*I_1$.

15.2 I charge method (Appendix 2)

- Charge the fully discharged battery for seven hours at $0.2*I_1$.

15.3 II charge method (Appendix 3)

- Charge the fully discharged battery with parameters selected from the table below and afterwards charge for two hours at $0.2*I_1$
- Check battery current switching to $0.2*I_1$ at the stage 1(max) time presented in the table below.

current	Stage 1 time (max)
$0.4*I_1$	180
$0.6*I_1$	120
$0.8*I_1$	90

16. Allow the battery to stand for one hour to support the escapes of charging gases from cells.

17. Tighten the vents between 1 and 24 hours after charging and fit the lid onto the case.

18. Release the battery to service, if required in accordance with Task 3.3.

Identify cells for replacement. Refer to Task 10.7.

Task 7.3 – Annual maintenance of airborne batteries

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Remove the lid and check that the gasket is fully adhered to the lid.	Any damage found, record defect and replace in accordance with the Repair Task 10.6.
2. Inspect battery container and lid for any damages, signs of dents, cracks, splits, overheating, short circuits, melting, dark spots and tarnish.	Any damage found, record defect and replace in accordance with the Repair Task 10.6.
3. Inspect the main connector for signs of damage caused by arcing, faulty connection, corrosion, loose parts and cracks in the connector casing.	Any damage found, record defect and replace in accordance with the Repair Task 10.5.
CAUTION: **Mineral salts from spilled electrolyte are caustic. When cleaning batteries and cells wear goggles and gloves; in addition wear dust mask and ear protection when applying compressed air for cleaning; the compressed air shall have a pressure below 3 bar.** 4. Tighten any loose vent plugs and clean the top of the cells with a plastic brush, and remove any remaining deposits with an oil-free compressed air.	
5. Tighten and torque the upper nuts as detailed in section 1.6.2, table 1.	
6. Inspect visually harnesses with temperature switches, thermistors, thermocouples, and for loose wiring, cracks, dents, connector pins in place and any damages.	Any damage found, record defect and replace in accordance with the Repair Task 10.4.
7. Measure and record cell voltages.	
8. Mark cells with voltages lower than 1.2V (as possible defective cells).	
9. Undo the vents and keep them aside on the cells mouth. **ATTENTION** **Do not top up the cells with water at this stage.**	
10. Connect the battery to the charge / discharge unit.	
ATTENTION **Do not use mercury thermometer.** 11. Check the battery temperature; Requirement: below 35°C.	Soak the battery to ambient room temperature, which can take up to 8 hours.

12. Discharge the 24 V battery at I_1 to 20 V. (pay particular attention to previously marked cell in step 8).

Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1.0V.

Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below.

Record the cell voltages at the corresponding time indicated in column 2 in the log book.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

If the requirement is not met, then continue with Task 8.1, "Reconditioning."

13. Continue discharge at $0.1*_1$ to an average of 0.5 volt per cell.

14. Tighten all vents.

15. Disassembly.

ATTENTION: Do not loose the lower nuts of the cell terminals.

15.1 Undo and remove the upper pole nuts

15.2 Remove washers, and intercell links

15.3 Remove the thermostat assembly from cells, if any

15.4 Identify cell positioning within the case

15.5 Remove all the cells from the case starting with the middle cell of each row using the appropriate insulated cell puller.

15.6 Remove insulating material from the case, also noting their positions

15.7 Undo the thermostat connectors and remove the harness in one-piece from the battery case

15.8 Remove the main connector, only if defective.

16. Carry out battery cleaning in accordance with Task 8.6.

17. Inspection and check.

17.1 Check the disassembled upper pole nuts, washers, and intercell links for signs of damage and corrosion.

Replace as necessary in accordance with Task 10.2.

17.2 Check the cells for thermal damage and discolouration.

Replace as necessary in accordance with Task 10.7.

17.3 Check the cable assembly with thermostats / thermistors (if any) for signs of damage

Replace the assembly as necessary in accordance with Task 10.4.

17.4 Test the thermostat and thermistor functions as detailed under Task 8.7.

Replace as necessary in accordance with Task 10.4.

18. Reassembly the battery

CAUTION:
Incorrect assembly harms the airworthiness of the battery and will result in additional repair work. Use always the battery components in accordance with the corresponding IPL.

- Fit the main connector into the battery case (if replaced)
- Fit the thermostat harness assembly connector into the battery case
- Place the liners, the cells and dummy cells, packing pieces and heater mats (if any) into the original positions of the battery case according to the IPL
- Tighten the lower pole nuts with an calibrated torque wrench according to the torque in table 1 of section 1.6.2
- Place intercell links on cells terminals
- If shown on the IPL, place the intercell links fixed to the thermostat assembly on the terminals of the corresponding cells
- Place spring washers on the intercell links and screw upper nuts on the pole threads
- Tighten the upper pole nuts using an calibrated torque wrench with the torque issued in table 1 of section 1.6.2.

19. Refit the lid and test the insulation resistance as described in Task 8.3

20. Remove the lid.

21. Connect the battery to the charge/discharge unit.

22. Remove the vents.

23. Test the vent's response pressure as detailed in Task 8.5.

24. Charge the battery for 8 hours at $0.2*I_1$ as shown in Appendix 2 – commissioning charge.

    Adjust the electrolyte level 15 minutes before the end of charge.

25. Stand the battery for 1 hour.

26.Discharge the 24V battery at I_1 to 20V

REQUIREMENT: The voltage of each cell after 48 minutes must be equal / greater than 1 Volt.

NOTE: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below.

Record the cell voltages at the corresponding time indicated in column 2 in the log book.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

27. Allow the battery to soak to room temperature, which can take up to 8 hours

28. Recharge the battery using either 28.1, or 28.2 or 28.3

- Adjust the electrolyte level at a current of $0.2*I_1$ 15 minutes to 10 minutes prior to end of the charge methods, 28.1, 28.2, and 28.3
- Afterwards measure the voltage on each cell prior to the end of charge at $0.2*I_1$.

Requirement: cell voltage shall be ≥ 1.56 V.

- Record cells end of charge voltages in the logbook.

ATTENTION:

- **Don't charge the battery with currents higher than I_1**
- **If you can't fully supervise, don't use method described in 28.3.**

28.1 IUI charge – method (Appendix 1).

- **Charge the battery at I_1 until voltage has increased to 1.55V times number of cells and charge for 2 hours at $0.2*I_1$**
- **After about 1 hour charge, check that battery has reached the voltage level to switch the charge current to $0.2*I_1$.**

28.2 I charge method (Appendix 2).

- **Charge the fully discharged battery for seven hours at $0.2*I_1$.**

28.3 II charge method (Appendix 3)

- **Charge the fully discharged battery with parameters selected from the table below and afterwards charge for two hours at $0.2*I_1$**
- **Check battery current switching to $0.2*I_1$ at the stage 1(max) time presented in the table below.**

current	Stage 1 time (max)
$0.4*I_1$	180
$0.6*I_1$	120
$0.8*I_1$	90

29. Measure the electrolyte density on cells in accordance with Task 8.4.

30. Refit the vents on the cells between 1 hour and not later than 24 hours after charge.

31. Refit the lid on the battery case.

32. Measure the insulation resistance in accordance with Task 8.3
Requirement: Insulation resistance ≥10 MΩ.

If less than 10 MΩ, remove the lid and allow the battery to stand for 24 hours in a dry ventilated environment.

33. Release the battery to service, or if required in accordance with Task 3.3.

8. Sub-Tasks of maintenance / commissioning procedures

Task 8.1 – Reconditioning of cells underperforming discharge capacity requirements

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR

Note:

For charged batteries from service containing cells returning less than 80% of its nominal capacity output, this reconditioning is advised. Prior to any ultimate costly replacement of cells, it should be proven that the reason for failing the requirement is not caused by a reversible capacity loss. (compare section 1.5.8) In most cases one cycle consisting of deep discharge, recharge and capacity test would be sufficient to meet the capacity requirement. Two cycles can be carried out to proof the reproducibility of cell's performance. If no improvement in capacity output relative to the previous measurement(s) could be achieved the cells are irreversibly aged and shall be replaced.

1. Deep discharge the cells

   When the battery is discharged at rates between $0.2*I_1$ and I_1 to 20 V connect 1 ohm/2 watt resistors for 24 hours up to 72 hours between the positive and the negative terminal of each cell. If no resistors are available, discharge the battery at $0.1*I_1$ to 0.5V per cell and store the battery for 4 hours (minimum.)

2. Remove the resistor and charge the battery for 8 hours at $0.2*I_1$ as shown in Appendix 2. If necessary, adjust the electrolyte level of the cells 10 to 15 minutes prior to the end of charge.

   Measure and record the cell voltages prior to the end of charge.

3. Stand the battery for 1 hour.

4. Discharge the 24V battery at I_1 to 20V.

   Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1 Volt

   Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

   Record the cell voltages at the corresponding time indicated in column 2 in the log book.

5. Soak the battery to room temperature, which can take up to 8 hours.

6. Charge the battery for 7 hours at 0.2*I_1 as shown in Appendix 2, adjust the electrolyte level and read and file cells end of charge voltages prior to the end of charge Requirement: ≥ 1.56 V.	Identify cells for replacement. Refer to Task 10.7.
7. Stand the battery for 1 hour.	
8. Discharge the 24V battery at I_1 to 20V. Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1 Volt. Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below. Record the cell voltages at the corresponding time indicated in column 2 in the log book.	Replace the cells underperforming the charge or/ and discharge voltage requirements in accordance with Task 10.7.
9. Record the data in the log book.	
10. Record in the battery log book whether the battery has passed or failed.	
11. Continue in accordance with Task 7.2 step 14 or 7.3 at step 14 or Task 10.1 step 13.	

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
0.2*I_1	240	≥1.0
0.4*I_1	120	≥1.0
0.6*I_1	80	≥1.0
0.8*I_1	60	≥1.0
I_1	48	≥1.0

Task 8.2 – Check and adjust the torque of the lower pole nuts

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION **The torque of the lower pole nut shall be checked and adjusted only at the annual maintenance.** **Before adjustment, discharge the battery with 0.2*I_1 to 0.5 V per cell.**	Identify cells for replacement. Refer to Task 10.7.
1. Undo and remove the upper pole nuts.	
2. Remove the washers and intercell links.	
3. Remove the thermostat assembly (if any).	
4. Tighten the lower pole nuts and check the torques with an appropriated and calibrated torque wrench as indicated in the table 1 of section 1.6.2.	
5. Refit the washers and intercell links.	
6. Refit intercell links of thermostat assembly (if any).	
7. Tighten the upper pole nuts and check the torques with an appropriated and calibrated torque wrench as indicated in the table 1 of section 1.6.2.	

Task 8.3 – Insulation resistance measurement

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
CAUTION Read the safety instructions for the High voltage – Insulation resistance tester.	
1. Measure the insulation resistance with a MΩ-meter at 250 V DC between the + pin of the battery connector and the battery case.	If the insulation resistance is below 0.5 MΩ subject the battery to battery cleaning Task 8.6.
2. Record the values in the battery log book.	

Task 8.4 – Check of electrolyte density

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OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
CAUTION Wear appropriate PPE (personal protective equipment). **Attention** **Avoid spilling of electrolyte into the battery during the measurements.** **Do not change cells electrolyte.** NOTE Any measurement of electrolyte density directly after an adjustment of cells electrolyte level with water may result in values below the requirement. Always measure the electrolyte density after the charge following the electrolyte adjustment on fully charged cells.	
1. 15 minutes after the recharge, measure the temperature with a thermometer and the density of the electrolyte with a hydrometer or an electronic density meter on 3 random selected cells out of a 20 cells battery. Requirement: 1.30 kg/L ≥ Density: ≥ 1.26kg/L.	If density values are below the required value, measure the density of all cells and replace according to Task 10.7. If the density are above 1.3 kg/L. Check whether electrolyte was adjusted correctly before. Check whether electrolyte temperature is considerably below 20°C. Check whether battery was charged.
2. Continue in Task 7.3 at step 30.	

Task 8.5 – Testing vents response pressure after cleaning

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION: • **Spare parts used for any repair listed below have to comply with the IPL.** • **Do not store wet vents in plastic bags.** NOTE Before testing the vents ensure they have been cleaned in accordance to Task 8.6. Specialized test equipment is commercially available; Appendix 5.	
1. Check the vents and its sealing rings visually for damages; cracks and breaks on vent bodies as well as for distortion. Ensure the spring is still attached to the vent body.	Replace damaged vents and / or their damaged sealing rings.
2. • Fix the vent with its O-ring into the appropriate adapter • Attach the adapter to the adjustable pressure-reducing device • Submerge the adapter and vent in a container of water • Increase the pressure slowly • Record the pressure when the vent opens (indicated by bubbles) • Stop the pressure source. Allow air pressure to be vented through the valves • Requirement: for the vent pressure: see table 1 at section 1.6.2.	If vents operate outside the parameters defined in table 1 of section 1.6.2, replace vents.

Task 8.6 – Battery cleaning procedure of any disassembled battery component

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
Note: If the insulation resistance value of the battery is smaller than 0.5 MΩ, Battery cleaning shall be carried out. **Do not use any other solvent than soapy water for cleaning disassembled battery components.**	
1. Remove any contamination of connectors and harnesses with a damp cloth, soaked in a soapy water solution.	
2. Clean all remaining disassembled battery components, e.g. battery case, liners, vent plugs in a solution with soapy water. Afterwards rinse with fresh water.	
NOTE: it is recommended that drying with the pressurised air-supply should be below 3 bar. 3. Allow all components to dry naturally, or supported by oil-free pressurised air.	
4. Coat all disassembled and cleaned metallic components with silicone spray (Appendix 8 , consumables).	
5. Continue in Task 7.3 step 17.	

Task 8.7 – Functional Test on thermostats / thermistors and temperature switch assemblies

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION **Spare parts used for replacement have to comply with the IPL.** **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V per cell.** **Do not overheat the device. Temperatures above 110°C can damage the switch.** NOTE Identify the thermostats that operate above room temperature and proceed test 1, otherwise Test 2. NOTE Temperature switch assemblies shall be tested at the annual maintenance. Alternatively, these may be replaced. For function testing it is necessary to disassemble the temperature sensing harness from the battery.	
Test 1: Thermostats above ambient temperature	
1.a Identify the thermostat type and its switching temperature according to Appendix 4	
1.b Disassemble the battery to the state necessary to remove the switch assembly together with the corresponding connector	
1.c Fix the link with the thermostat on the test fixture	
1.d Connect the relevant pins in the interface connector of the thermostat assembly to an ohmmeter	
1.e If necessary, connect a thermocouple on the link as close as possible to the switch	
1.f Record the ambient temperature	
1.g Record the measured thermal switch position at ambient temperature (opened or closed)	
1.h Heat the fixture to a temperature of 10°C above the switching temperature and maintain it at this level until the switch operates	
1.i Record the corresponding temperature when the switch operates	
1.j Remove the heat source, allowing the link to cool whilst monitoring the ohmmeter for the thermostat to switch to its normal state	Replace the thermostat / thermistor assembly in accordance with Task 10.4.
1.k Record the temperature at which the thermostat switches to its normal state	
1.l Identify faulty switches that do not switch or frequently switch within the switching temperature range	
1.m Refit the switch assembly on the battery.	

Test 2: Thermostats below ambient temperature

CAUTION
Spraying human skin and tissue with coolant causes serious injuries (burns) by freezing. Read safety instructions about cooling spray.

2.a Identify the thermostat type and its switching temperature according to the Appendix 4

2.b Disassemble the battery to the state necessary to remove the switch assembly together with the corresponding connector

2.c Fix the link with the thermostat on the test fixture

2.d Connect the relevant pins in the interface connector of the thermostat assembly to an ohmmeter

2.e If necessary, connect a thermocouple on the link as close as possible to the switch

2.f Record the ambient temperature

2.g Record the measured thermal switch position at ambient temperature (opened or closed)

2.h Cool the fixture with the freezing spray to a temperature of 10°C below its switching temperature and maintain it at this level until the switch operates

2.i Record the corresponding temperature when the switch operates

2.j Stop cooling the link, and allow the link temperature to rise whilst monitoring the ohmmeter for the thermostat to switch to its normal state

2.k Record the temperature at which the thermostat switch to its normal state

2.l Identify faulty switches that do not switch or exhibits irregular switching operation

2.m Refit the switch assembly on the battery,

Replace the thermostat / thermistor assembly in accordance with Task 10.4.

Test 3: Thermistors

1. Connect the terminals of the ohmmeter to the pins of the thermistor.
2. Measure the temperature of the link (plate) with the thermistor is fitted using an electronic thermometer
3. Measure the resistance.
4. Compare the measured temperature and resistance of the thermistor with the curve in the corresponding IPL
5. A properly functioning positive temperature coefficient thermistor will show a smooth and steady increase in ohmic resistance. Consequently a properly functioning negative temperature coefficient thermistor will show a smooth and steady decrease in ohmic resistance. Using a suitable heat source heat the thermistor link (plate) ensuring not to exceed a temperature of 70°C (Alternatively the link can be cooled with freezing spray).
6. Signs of faulty thermistors:
   a) Steady reading that does not change
   b) a reading of zero
   c) reading of infinity are all indications erratic reading.

Replace the thermostat / thermistor assembly in accordance with Task 10.4.

9. Fault finding (Unscheduled maintenance)

The table below identifies the tests and inspections to diagnose a fault condition as a result of an unscheduled removal of the battery from aircraft.

Problem	Possible Reason	Check Refer to Task	Corrective action	
Zero volt at battery connector	Intercell links broken, Main connector damage,	10.1	Task 10.2 Task 10.5	Task 10.9
Zero volt cell	Short circuit	10.1	Task 10.7	Task 10.9
Minus volt cell	Cell installed and operated in reverse	10.1	Task 10.7	Task 10.9
Reduced discharge performance	Low compression of the cells within the battery	10.1	Task 10.8	Task 10.9
	Increased internal resistance due to low torque connection of upper pole nuts	10.1	Task 10.2	Task 10.9
	Cell installed in reverse	10.1	Task 10.7	Task10.9
	Corroded nuts, links, washers, and main connector parts	10.1	Task10.2 Task 10.3	Task 10.5 Task 10.9
	Low capacity cells due cell's imbalance	10.1	Task 8.1	Task 10.9
	Low capacity cells (irreversibly aged)	10.1	Task 10.7	Task 10.9
	Cells dried out	10.1	Task 10.7	Task 10.9
Immediately breakdown of discharge voltage	Damaged main connector	10.1	Task 10.5	Task 10.9
	Faulty cell	10.1	Task 10.7	Task 10.9
	Loose pole nuts, broken spring washers	10.1	Task 10.2	Task 10.9
	Main connector defect	10.1	Task 10.5	
	Cells, heavily dried out	10.1	Task 10.7	Task 10.9
	Battery deep discharged	10.1	Task 10.9	
Cell top of charge voltage of <1.56V	Separator system inside cell defect	10.1	Task 10.7	Task 10.9
Low insulation resistance	Any leakage of electrolyte, or conductive liquids and moisture	8.3	Task 8.4 Task 8.5 Task 8.6	Task 10.3 Task 10.9
	Leakage caused by cell short circuit	8.3	Task 8.6 Task 10.7	Task 10.9
	Leakage due to defective vents	8.3	Task 8.4 Task 8.5	Task 8.6, Task 10.9,
	Leakage due to damaged cell cases	8.3	Task 8.6 Task10.7	Task 10.9
	Leakage due to faulty adjustment of electrolyte level	8.3	Task 8.4 Task 8.6	Task 10.9
Visible signs of serious thermal damages of battery component	Short circuits, dried out cells, defective temperature control	10.1	Replace battery,	
Thermostat does not switch	Defective thermostat	8.7	Task 10.4	Task 10.9
Damaged or distorted battery case / lid parts of stainless steel	Mechanical impact, transportation damage	10.1	Task 10.6	Task 10.9
Electrolyte density too low	Repeated cell's leakages	8.4	Task 10.7	Task 10.9
False Temperature indication	Defective switch assembly	8.7 10.1	Task 10.4	Task 10.9
	Loose upper pole nuts	10.1	Task 10.2	Task 10.9

10. Unscheduled Tasks

Task 10.1 – Inspection and diagnostic	
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Remove the lid and check that the gasket is fully adhered to the lid.	Any damage found, record defect and replace in accordance with the Repair Task 10.6.
2. Inspect battery container and lid for any damages, signs of dents, cracks, splits, overheating, short circuits, melting, dark spots and tarnish.	Any damage found, record defect and replace in accordance with Repair Task 10.6.
3. Inspect the main connector for any signs of damage caused by arcing, faulty connection, corrosion, loose parts and cracks in the connector casing.	Any damage found, record defect and replace in accordance with Repair Task 10.5
CAUTION Mineral salts from spilled electrolyte are caustic. When cleaning batteries and cells wear goggles and gloves; in addition wear dust mask and ear protection when applying compressed air for cleaning; the compressed air shall have a pressure below 3 bar. 4. Clean the top of the cells with a plastic brush, and remove any remaining deposits with an oil-free compressed air source.	
5. Tighten and torque the upper nuts as detailed in section 1.6.2, table 1.	
6. Inspect visually harnesses with temperature switches, thermistors, thermocouples, and for loose wiring, cracks, dents, connector pins in place and any damages.	Any damage found, record defect and replace in accordance with Repair Task 10.4
7. Measure the insulation resistance with a MΩ-meter at 250 V DC between the + pin of the battery connector and the battery case. Requirement: ≥0.5MΩ.	If R ≤ 0.5 MΩ, continue at Task 7.3 step 12 (Annual maintenance)
8. Measure and record battery and cell voltages.	
9. Undo the vents and keep them aside on the cells mouth. **ATTENTION** **Do not top up the cells at this step.**	
10. Connect the battery to the charge / discharge unit.	
ATTENTION **Do not use mercury thermometer.** 11. Check the battery temperature. Requirement: below 35°C.	Soak the battery to ambient room temperature, which can take up to 8 hours.
12. Discharge the 24 V battery at I_1 for to 20 V. Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1.0V.	If the requirement is not met, then continue with Task 8.1, “Reconditioning.”

Note: If the discharge at the I_1 rate is not feasible, select a different rate and criteria from the table below.

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

Record the cell voltages at the corresponding time indicated in column 2 in the log book.

13. Discharge the 24 V battery at $0.1*I_1$ to 10 V.

14. Remove the temperature assembly from cells (if any), but not its connector.

15. Carry out functional test on the thermostat in accordance with Task 8.7.

Requirement: thermostat shall switch

Replace the thermostat assembly in accordance with Task 10.4.

16. Fit the thermostat assembly.

17. Recharge the battery using either 17.1, or 17.2 or 17.3

- Adjust the electrolyte level at a current of $0.2*I_1$ 15 minutes to 10 minutes prior to end of the charge methods, 17.1, 17.2, and 17.3
- Afterwards measure the voltage on each cell prior to the end of charge at $0.2*I_1$.

Requirement: cell voltage shall be ≥ 1.56 V

- Record cells end of charge voltages in the logbook.

Identify cells for replacement. Refer to Task 10.7.

ATTENTION:

- **Don't charge the battery with currents higher than I_1**
- **If you can't fully supervise, don't use method described in 17.3.**

17.1 IUI-charge = IUI charge – method (Appendix 1).

- Charge the battery at I_1 until voltage has increased to 1.55V times number of cells and charge for 2 hours at $0.2*I_1$
- After about 1 hour charge, check that battery has reached the voltage level to switch the charge current to $0.2*I_1$.

17.2 I charge method (Appendix 2).

- Charge the fully discharged battery for seven hours at $0.2*I_1$.

17.3 II charge method (Appendix 3)

- Charge the fully discharged battery with parameters selected from table below and afterwards charge for two hours at $0.2*I_1$
- Check battery current switching to $0.2*I_1$ at the stage 1(max) time presented in the table below.

current	Stage 1 time (max)
$0.4*I_1$	180
$0.6*I_1$	120
$0.8*I_1$	90

18. Refit and tighten the vents on the cells within 24 hours after charge.

19. Refit the lid on the battery.

20. If required, perform Release Task 3.3.

Task 10.2 – Replacement of upper pole nuts, spring washers and links

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR

ATTENTION:

- **Spare parts used for any repair listed below have to comply with the IPL**
- **Before disassembly, discharge the battery with $0.2*I_1$ to 0.5 V per cell.**

1. Remove any corroded nuts, spring washers and intercell links from the cells.

2. Fit new intercell links, spring washers and nuts.

3. Tighten the upper pole nuts on the terminals with the torque in accordance with section 1.6.2, table 1.

Task 10.3 – Replacement of lower pole nuts, sealing caps and seals

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
• **Only in case of corrosion and or leakage replacement can be considered.** **ATTENTION:** • **Spare parts used for any repair listed below have to comply with the IPL** • **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V per cell** • **To avoid potential leakage of electrolyte replace one lower pole nut and then the other, not both simultaneously** • **Pole nuts, sealing caps, and seals should be replaced in pairs.**	
1. Undo and remove the upper pole nuts 2. Remove the switch assembly if any is fixed on the cells 3. Remove the washers and intercell links from the cells 4. Undo one lower pole nut and dispose 5. Undo and dispose the sealing cap and seal 6. Replace the disposed parts with the new 7. Fit lower pole nut and torque with a calibrated torque wrench in accordance with section 1.6.2, table 1 8. Repeat steps 4, 5, 6, 7, to replace the other lower pole nut, limiting cap and seal of the cell 9. Check the integrity of the seals 10. Place the intercell links on the terminals or fix the thermostat switch assembly on the cell terminal 11. Tighten the upper pole nuts with the torque defined in table 1 section 1.6.2 12. Record the action in the log book.	In case of fail, replace the cell in accordance with Task 10.7.

Task 10.4 – Replacement of the Thermostat Switch Assembly

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION: • **Spare parts used for any repair listed below have to comply with the IPL** • **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V per cell** • **Switch assemblies cannot be repaired; they have to be replaced as a complete assembly.**	
1. Undo upper pole nuts on the battery 2. Remove spring washers, intercell links and switch assembly from the cells 3. Disassemble the battery to the state necessary to remove the switch assembly together with the corresponding connector 4. Replace switch assembly and install its connector 5. Reassemble the battery whilst keeping liners and cells in their original position 6. Place the links of the switch assembly, intercell links and spring washers on the terminals in accordance with the corresponding IPL. 7. Tighten the upper pole nuts with the torque detailed in section 1.6.2, table 1 8. Record the action in the log book.	

Task 10.5 – Replacement of the Main Battery Connector

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION: • **Spare parts used for any repair listed below have to comply with the IPL** • **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V times number of cells** • **The main battery connector cannot be repaired. It is to be replaced as a complete assembly.**	
1. Undo all upper pole nuts on the battery 2. Remove spring washers, intercell links and switch assembly if any from the cells 3. Disassemble the battery to the necessary state 4. Remove the main connector and its associated parts. 5. Fit new main connector assembly 6. Reassemble the battery, whilst keeping cells and liners in their original position 7. Check the torque of the lower pole nuts in accordance with section 1.6.2, table 1 8. Fit intercell links on the terminals on the cell terminal in accordance with the corresponding IPL 9. Tighten the upper pole nuts with the correct torque in accordance with section 1.6.2, table 1 10. Record the action in the log book.	

Task 10.6 – Replacement of the Battery Case and or Battery Lid

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR

ATTENTION
Spare parts used for any repair listed below have to comply with the IPL Before disassembly, discharge the battery with $0.2*I_1$ to 0.5 V per cell.

1. Lid

In case of any mechanical defects to the gasket or lid, replace the lid in accordance with the corresponding IPL and file the replacement action in the log book.

2. Battery case

2.1 Record from the log book / battery identification information Order battery case from supplier with the correct battery label information

2.2 On receipt of new battery case dismantle original battery as follows:

2.3 Remove the nuts together with washers, switch assembly if any, and intercell links

2.4 Remove cells, empty containers and liners from the damaged battery case

2.5 If re-usable, also remove the main battery connector from the battery case to be disposed and install it at the new box

2.6 Rearrange insulating material and cells at their original position in the new battery case

2.7 Check the torque of the lower pole nuts with a calibrated torque wrench (see section 1.6.2, table 1)

2.8 Place intercell links and switch assembly if any on the terminals in accordance with the corresponding IPL

2.9 Adjust the torque of the upper pole nuts in accordance with section 1.6.2 table 1

3 Record the action in the log book.

Task 10.7 – Replacement of Cell(s)

OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION: • **Spare parts used for any repair listed below have to comply with the IPL** • **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V per cell** • **If six cells in a 24V battery have been replaced from the original set, replace all cells** • **If there is evidence of thermal damage, remove all cells and inspect.** 1. Remove the necessary parts in order to remove defective cell(s) 2. Pull out the cell using cell puller. (see Appendix 5, item 12) 3. Dispose replaced cell(s) in accordance with local regulations 4. Fit new discharged replacement cell(s) into the block of cells 5. Refit harness if any, links, washers and upper pole nuts 6. Tighten the upper pole nuts with the torque as detailed in section 1.6.2, table 1 7. Record the action and the Serial-no. of the new installed cells in the log book.	

Task 10.8 – Replacement of insulating material (=liners / empty containers)

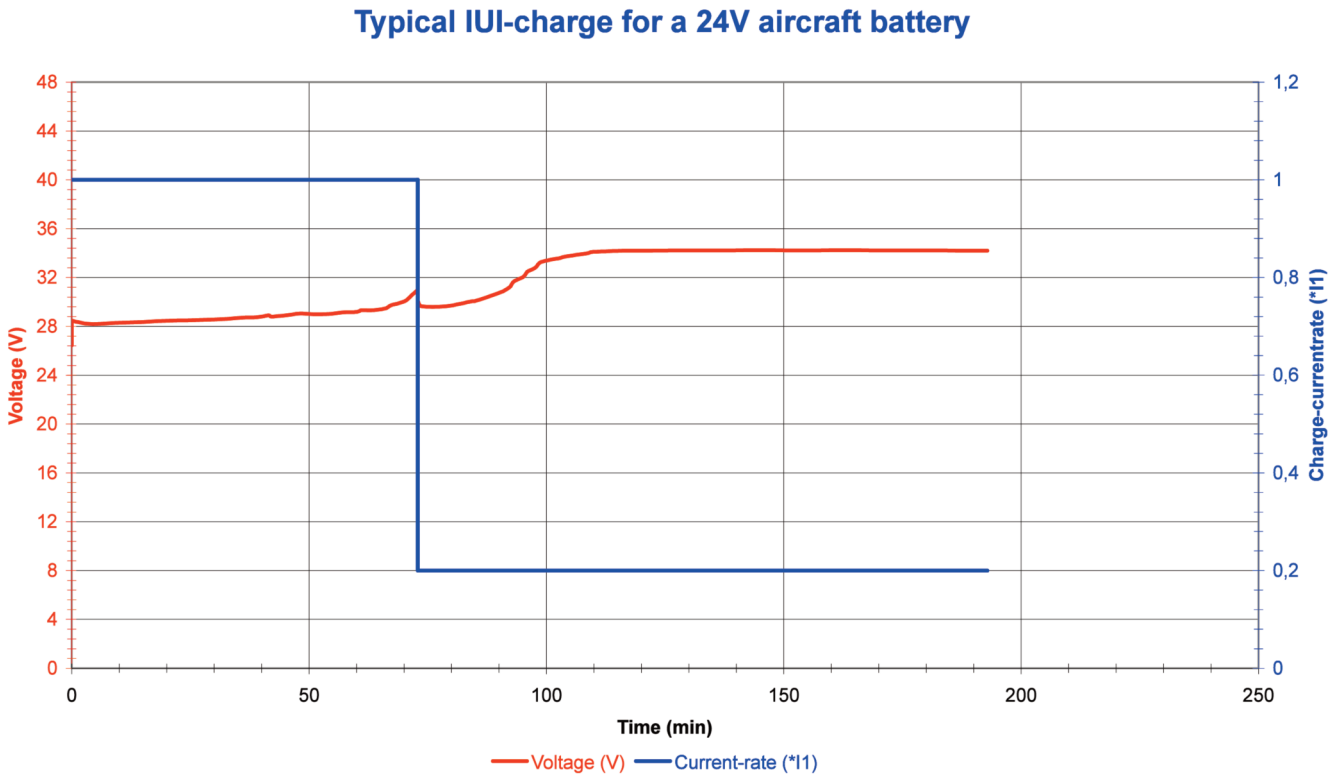
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
ATTENTION • **Any spare parts used for repair listed below must comply with the IPL** • **Due to tolerances in cell thicknesses the amount of plastic liners can deviate from the drawing in the IPL. The cells, reassembled together with new liners and empty containers shall be packed sufficiently to ensure there is no movement of cells within the battery box** • **Before disassembly, discharge the battery with 0.2*I_1 to 0.5 V per cell.** 1. Undo and remove all upper pole nuts on the cells 2. Remove spring washers, intercell links and switch assembly, (if any) 3. Remove cells, (noting position) and the insulating material from the battery case. 4. Install new insulating material and reassemble the battery whilst keeping cells in their original position 5. Refit the intercell links, washers, switch assemblies (if any), and nuts in accordance with the corresponding IPL 6. Tighten the upper pole nuts with the torque as detailed in section 1.6.2, table 1.	

Task 10.9 - Commissioning of repaired batteries

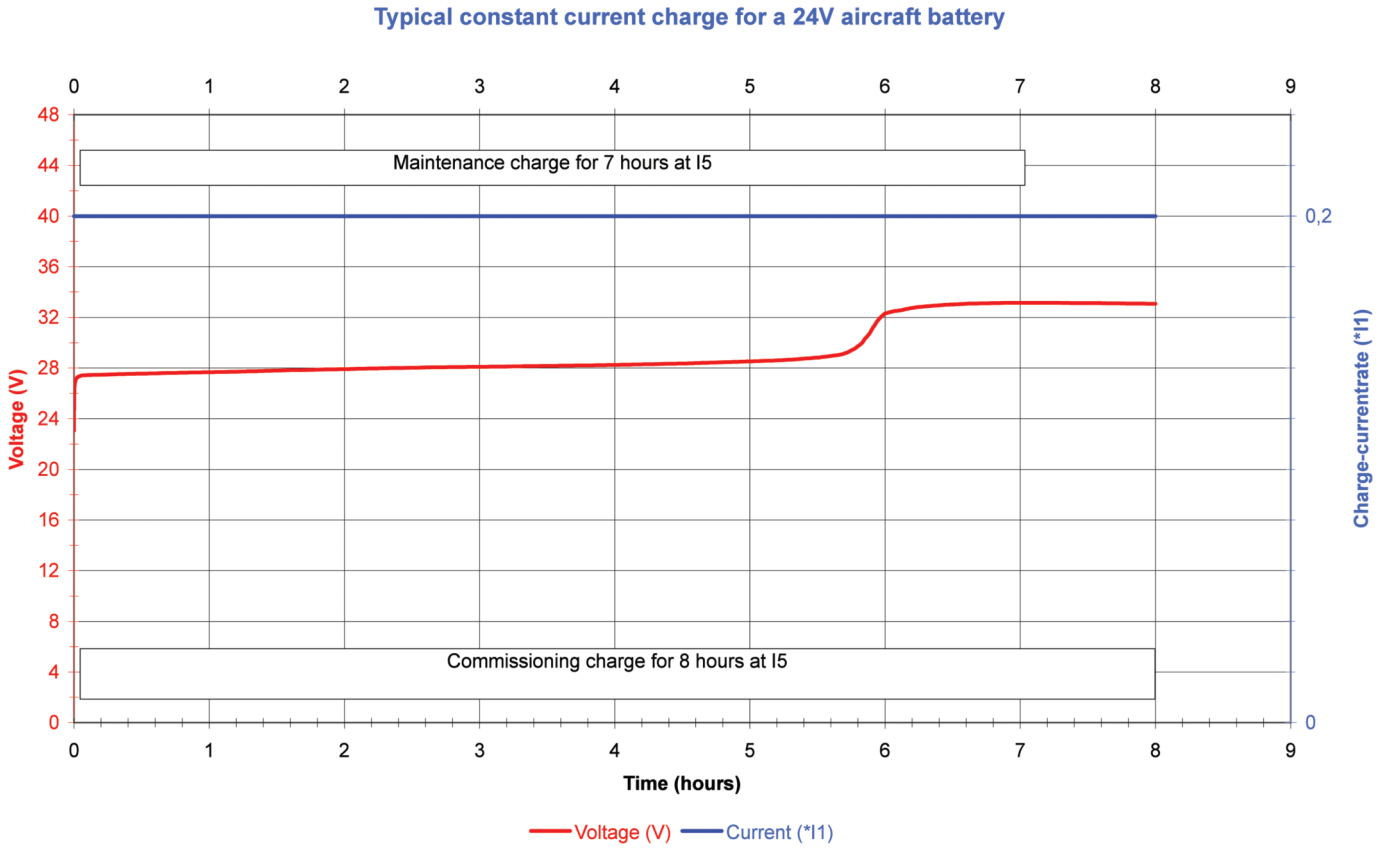
OPERATING INSTRUCTION AND TECHNICAL REQUIREMENTS (TR)	INSTRUCTIONS / EVIDENCE WHEN DEVIATIONS FROM TR
1. Measure the insulation resistance in accordance with Task 8.3 Requirement: R>0.5 MΩ.	Carry out battery cleaning, Task 8.6.
2. Remove the lid from the battery.	
3. Connect the battery to the charge / discharge unit.	
4. Undo the vents from the cells and keep them aside on cell's mouth.	
5. Charge the battery for 8 hours at $0.2*I_1$.	
6. Allow the battery to stand for 1 hour.	
7. Discharge the 24V battery at I_1 to 20V. Requirement: The voltage of each cell after 48 minutes must be equal / greater than 1 Volt. Note: If the discharge at the I_1 rate is not feasible, select a different discharge rate and criteria from the table below: Requirement: Cell voltage shall be ≥1.0V at the defined discharge time in column two.	Replace all cells, if more than 6 cells from the original 24V battery have failed the discharge requirement.
8. Allow the battery to soak to room temperature, which can take up to 8 hours.	
9. Charge the battery either for 7 hours at $0.2*I_1$ (Appendix 2) or apply the IUI-method (Appendix 1) adjust the electrolyte level prior to the end of charge and measure the end of charge voltages of the cells. Requirement: >1.56 V	Replace all cells, if more than 6 cells from the original 24V battery have failed the charge requirement.
10. Record the results in the log book.	
11. Tighten the vents between 1 hour and 24 hours after charge.	
12. Refit the lid on the battery.	
13. Measure the insulation resistance in accordance with Task 8.3 Requirement: R>0.5 MΩ.	Carry out battery cleaning, Task 8.6.
14. Release the battery to service, if necessary, in accordance with Task 3.3.	

Discharge current rate	Time (min) cell voltage reading	Voltage requirement for cells (V)
$0.2*I_1$	240	≥1.0
$0.4*I_1$	120	≥1.0
$0.6*I_1$	80	≥1.0
$0.8*I_1$	60	≥1.0
I_1	48	≥1.0

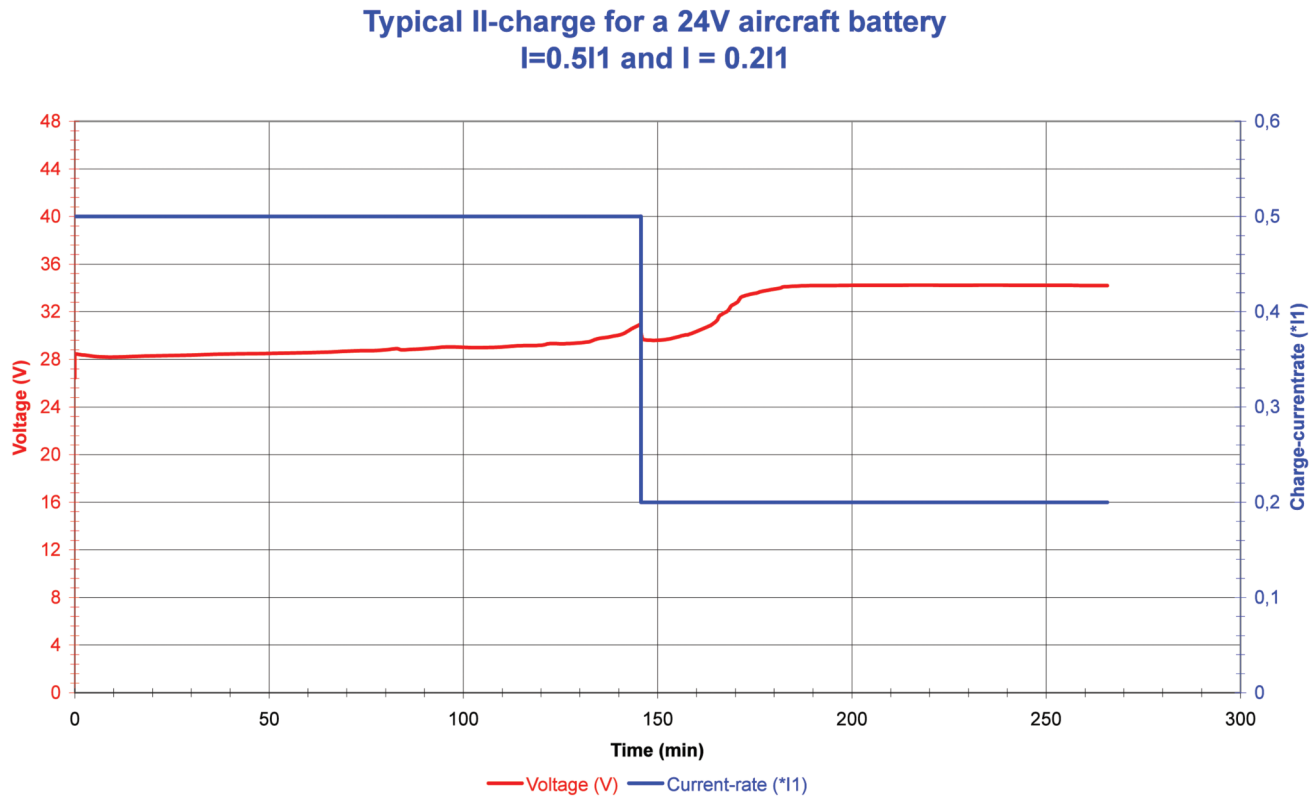
APPENDIX 1: IUI-CHARGE



APPENDIX 2: CONSTANT CURRENT CHARGE:



APPENDIX 3: II-CHARGE



APPENDIX 4: TEMPERATURE HARNESSES

Battery	Mat. No SAP No	Thermostat assembly	Mat. No SAP No	Amount of Thermostats	Colour	NCC/ NOC	Switching range
Buttonthermostat 70°C							
F 20/7 H1C T-E2	334 9007 3001 2314837	Temperature sensor	308 9946 191 2300329	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/40 H1C T	334 9040 9206 2316002	Temperature sensor	308 994 6192 2300345	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/27 H1C T70	334 9027 910 2315599	Temperature sensor	308 9946 200 2300394	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/25 H1C T ELC	334 9025 910 2300418	Temperature sensor	308 9946 202 2300418	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/40 H1C T2 (P)	334 9040 9201 2315955	Temperature sensor	308 9946 204 2300434	2x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/17 H1C T-2	334 9017 950 2315088	Temperature sensor	308 9946 215 2300467	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
20/FP 25 H1C T-R	334 9025 950 2315396	Temperature sensor	308 9946 225 2300475	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
20/FP38 H1C T-R with Connector	334 9038 9011 2315785	Temperature sensor	308 9946 226 2300483	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
20/FP38 H1C T-R without Connector	334 9038 901 2315769	Temperature sensor	308 9946 2262 2300515	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
20/FP 38 H1C T2-R	334 9038 9010 2315777	Temperature sensor	308 9946 227 2300523	2x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/44 H1C T	334 9045 920 2316198	Temperature sensor	308 9946 269 2300791	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F20/40 H1 E1 T	334 3409 1301 2314594	Temperature sensor	308 9946 351 2300961	1x Thermostat	Red	NOC	70°C ± 1.7°C
F20/27 H1C MT	334 9027 700 2315493	Temperature sensor	308 9946 359 2301033	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/27 H1C M1 T	334 9027 7000 2315509	Temperature sensor	308 9946 359 2301033	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F 20/4 H1C T	334 9004 920 2314789	Temperature sensor	- 2818252	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F20/44 H1C WT	334 9045 9202 2316221	Temperature sensor	- 2819435	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
F20/17 H1C T	334 9017 960 2315096	Temperature sensor	308 9946 199 2821905	1x Thermostat	Yellow	NOC	70°C ± 1.7°C
Buttonthermostat 60°C							
F19/25 H1 T2	3343258140 2314456	Temperature sensor	308 9946 354 2300994	2x Thermostat	Green	NOC	60°C ± 1.7°C
F 20/40 H1C T2-1	334 9040 9202 2315963	Temperature sensor	308 9946 355 2301009	2x Thermostat	Green	NOC	60°C ± 1.7°C
F20/40 H1C T2	334 9040 9205 2315996	Temperature sensor	- 2809909	2x Thermostat	Geen	NOC	60°C ± 1.7°C
Buttonthermostat 60+70°C							
F 19/25 H1C T2 ELC	334 9025 820 2315266	Temperature sensor	308 9946 352 2300978	1xThermostat(60°) 1xThermostat(70°)	Green Yellow	NOC NOC	60°C ± 1.7°C 70°C ± 1.7°C
F 20/25 H1C T2 ELC	334 9025 920 2315355	Temperature sensor	308 9946 352 2300978	1xThermostat(60°) 1xThermostat(70°)	Green Yellow	NOC NOC	60°C ± 1.7°C 70°C ± 1.7°C
F 20/40 H1C T3	334 9040 9209 2316035	Temperature sensor	308 9946 445 231041	1xThermostat(60°) 1xThermostat(70°) 1xYSI-NTC Resistor.	Green Yellow Black	NOC NOC	60°C ± 1.7°C 70°C ± 1.7°C
F 20/27 H1C T2	334 9027 940 2315647	Temperature sensor	- 4448191	1xThermostat(60°) 1xThermostat(70°)	 Yellow	NOC NOC	60°C ± 1.7°C 70°C ± 1.7°C
NTC-Thermistor							
F 20/40 H1C WT	334 9040 930 2316043	Temperature sensor	308 9946 274 2300831	NTC-Thermistor	Red	NOC	33 KOHM
F20/44 H1C WT	334 9045 9202 2316221	Temperature sensor	- 2819443	NTC-Thermistor	Red	NOC	33 KOHM

APPENDIX 5:

RECOMMENDED TOOLS AND CONSUMABLES FOR BATTERY MAINTENANCE

No.	Designation	Technical data	Application	P/N of manufacturer	Sap
1.	Universal charger and discharger type UL 10 Or other suitable commercial units	Refer to the UL 10 datasheet	Charge and discharge of airborne batteries	552 0200 000	
2.	Voltmeter	0-40 V accuracy 1.0	Voltage test	Commercial unit	
3.	Digital voltmeter	0-40 V accuracy 1.0	Voltage test	Commercial unit	
4.	Digital multimeter	0-40 V accuracy 1.0	Voltage, current, resistance test	Commercial unit	
5.	Insulation tester		Insulation test	Commercial unit	
6.	Temperature measuring unit	0-100°C tolerance ±1%	Temperature test of the temperature sensor	Commercial unit	
7.	Digital thermometer	50…+150°C	Temperature test	Commercial unit	
8.	Tool box with special HAWKER® tools Size No: 42 Complete: aerometer, thermometer, protective gloves, brush, funnel, spec. wrench, valve spanner, spare parts (5 vents, 5 pole nuts, 5 limiting caps, 5 sealing rings, 5 spring washers).	For batteries 44/40/38/27 (Ah)	Battery maintenance	929 1480 770	
9.	Tool box with special HAWKER® tools Size No: 43 Complete is analogous to Size No: 42.	For batteries 25/22 A·h	Battery maintenance	929 1480 780	
10.	Tool box with special HAWKER® tools Size No: 44 Complete is analogous to Size No: 42.	For batteries 17/15/7/4 (Ah)	Battery maintenance	929 1480 790	
11.	Insulated torque wrench	0.5-20.0 Nm (5-200 kpcm)	Tightening cell pole nuts	Commercial unit	
12.	Cell puller	For all battery types	Pulling cells off, undoing and tightening pole nuts	929 1380 459	
13.	Plastic valve spanner M14	For batteries 45/40/38/27/25/22 Ah	Undoing and tightening vents	929 1380 4800	
14.	Plastic valve spanner M10	For batteries 17/15/7/4 Ah	Undoing and tightening vents	929 1380 4810	
15.	Protective gloves			Commercial	
16.	Protective glasses			Commercial	
17.	Syringe hydrometer with aerometer	Topping cells up Density measurement	Adjusting the electrolyte level, testing the electrolyte density	929 2014 054	
18.	Electronic density meter			Commercial	
19.	Thermometer (fracture-proof)	0-80°C	Measuring battery temperature	Commercial unit	
20.	Vessel for filling up with distilled water	1 liter	Adjusting the electrolyte level	928 7611 030	
21.	Plastic brush		Cleaning the battery	Commercial unit	
22.	Resistor for discharging single cells	1 ohm / 2 watt	Overhaul	4611908	
23.	Fixture for heating thermostats in switch assemblies		Heating thermostats	Commercial unit	
24.	Device for testing pressure on vents		Testing response pressures	Commercial unit	

APPENDIX 6:

CONSUMABLE FOR MAINTENANCE

No.	Designation	Purpose	Standards	Application	Note
1.	Water for topping up cells	Adjusting the electrolyte level	IEC 993 EN 60993	Topping up cells, Cleaning vents	
2.	Korasilone M	Protecting the bare parts of the cells and all hardware		Coating metallic surface of battery case and live parts	928 7200 017
3.	Liqui – Moly 3310	Protecting the bare parts of the cells and all hardware		Coating metallic surface of battery case and live parts	Commercial

APPENDIX 7:

DISPOSAL

Dispose of in accordance with local regulations. If in doubt, contact

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58089 Hagen
Germany

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Fax: +49 (0)23 31-372-183
email: info@de.enersys.com

Notes

Notes

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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