HAWKER®

GREEN LIGHT TO USE WHEN YOU LIKE

Hawker® XFC™ Bloc battery solutions for small traction applications

CONTENTS

INTRODUCTION

Since its introduction in the early 1990s, thin plate pure lead (TPPL) batteries have been established as a premium high performance battery suitable for a wide range of demanding applications. Today, the TPPL technology can be found in applications as diverse as emergency power, avionics, medical, military and consumer equipment.

Hawker® XFC™ batteries utilise the principles of advanced thin plate pure lead technology, to achieve exceptionally high performance, energy density and cycling capability. These characteristics make the Hawker XFC range ideal for use in motive power applications such as Floor-care, Pallet Trucks, AGV's, Personnel Carriers and Utility Vehicles.

This manual describes the Hawker XFC product range, physical characteristics and the basic information on storage operation and maintenance.

SAFETY PRECAUTIONS

Motive power batteries for small traction Valve Regulated Lead Acid (VRLA) monoblocs Hawker XFC series: TPPL technology.

Hawker XFC batteries are designed using proven gas recombination technology, which removes the need for regular water addition. The use of gas recombination technology for lead acid batteries has completely changed the concept for motive power. This new technology gives the user greater freedom to use valve regulated lead acid batteries in a much wide range of applications.

The minimal level of gas emissions from this type of battery allows the battery to be utilised in applications where previous restrictions might have been enforced. The Hawker XFC range is considered to be maintenance free, therefore there is no need for any routine water refilling to be carried out on the battery.

- 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 or DIN EN 50272-3, DIN EN 50110-1.

- Keep children away from batteries!

- 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.

- 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, wristwatches and articles of clothing with metal parts that might come into contact with the battery terminals.

- 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. Ensure secure installation! Use only suitable handling equipment.
- Lifting hooks must not damage the blocs, connectors or cables.
- Do not place batteries in direct sunlight without protection. Discharged batteries can freeze. For that reason, always store in a frost-free zone.

- Dangerous electrical voltage!
- Avoid short circuits: Hawker XFC 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

Warning: Do not use any type of oil, organic solvent, alcohol, detergent, strong acid, strong alkali or petroleum based solvent or ammonia solution to clean the monoblocs. Such materials may cause permanent damage to the monobloc casing.

RECOMBINATION TECHNOLOGY

How gas recombination works:

When a charge current flows through a fully charged conventional lead acid cell, electrolysis of water occurs to produce hydrogen from the negative electrode and oxygen from the positive electrode. This means that water is lost from the cell and regular topping up is needed.

However, evolution of oxygen gas and hydrogen gas does not occur simultaneously, because the efficiency of recharge of the positive electrode is not as good as the negative electrode. This means that oxygen is evolved from the positive plate before hydrogen is evolved from the negative plate.

At the same time that oxygen is evolved from the positive electrode, a substantial amount of highly active spongy lead exists on the negative electrode before it commences hydrogen evolution.

Therefore, provided oxygen can be transported to the negative electrode, conditions are ideal for a rapid reaction between lead and oxygen:

i.e. This oxygen is electrochemically reduced on the negative electrode according to the following scheme,

$$2e^- + 2H^+ + {}^1/_2\, O_2 \rightarrow H_2O$$

and the final product is water.....

The current flowing through the negative electrode drives this reaction instead of hydrogen generation which would occur in a flooded cell.

This process is called gas recombination. If this process was 100% efficient no water would be lost from the cell. By careful design of the constituents within the cell, gas recombination up to 99% is achieved.

Principle of the oxygen Reduction Cycle

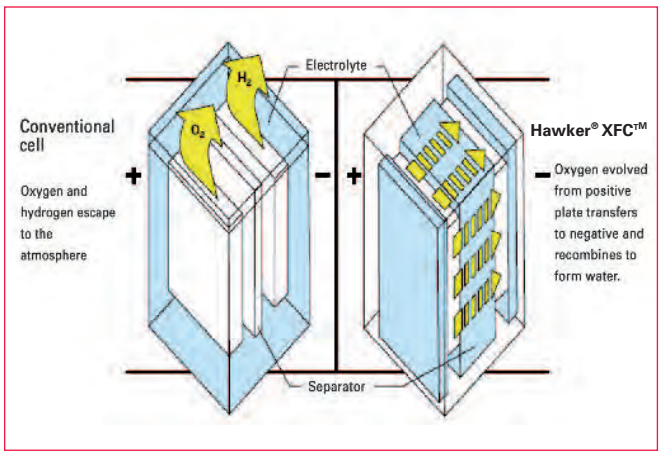


Figure 1 - Principle of the oxygen Reduction Cycle

RECOMBINATION EFFICIENCY

Recombination efficiency is determined under specific conditions by measuring the volume of hydrogen emitted from the battery and converting this into its ampere hour equivalent. This equivalent value is then subtracted from the total ampere hours taken by the battery during the test period, and the remainder is the battery's recombination efficiency and is usually expressed as a percentage. As recombination is never 100%, some hydrogen gas is emitted from Hawker® XFC™ batteries through the self-regulating valve; the I_{gas} value for this technology of battery is 1A/100 Ah C_5.

RANGE SUMMARY

A

B

C

RANGE SUMMARY
Available

Table 1 – Hawker XFC specifications

Monobloc Type	Nominal Voltage [V]	Nominal Capacity [C_5]	KW rating	Dimensions				Weight[1] [Kg]	No. of cycles[2]	Terminal Type	Terminal Layout
				L [mm]	W [mm]	Box Height [mm]	Terminal Height [mm]				
12XFC25	12	25	0.059	250	97	147	144	9.6	1200	M6 F [3]	A
12XFC35	12	35	0.085	250	97	197	194	13.2	1200	M6 F [3]	A
12XFC58	12	58	0.14	280	97	264	248	19.1	1200	M8 F	C
12XFC82	12	82	0.197	395	105	264	248	27.2	1200	M8 F	C
12XFC85	12	85	0.198	302	175	223	227	31.5	1200	M6 F [3]	B
12XFC115	12	115	0.273	338	173	272	273	43.0	1200	M6 F [3]	B
12XFC130	12	130	0.312	455	173	238	238	47.6	1200	M6 F	C
12XFC155	12	155	0.373	455	173	273	263	53.1	1200	M6 F	C
12XFC158	12	158	0.383	561	125	283	263	50.8	1200	M8 F [4]	C
12XFC177	12	177	0.433	561	125	317	297	58.8	1200	M8 F [4]	C

[1] +/- 3% [2] 60% Depth of discharge max [3] Can be fitted with SAE terminal [4] Can be fitted with M6 Male front terminal

ORIENTATION

Hawker® XFC™ batteries can be mounted in any orientation except inverted.

BATTERY CONFIGURATIONS

Hawker XFC blocs may be configured into a battery comprising series/parallel arrays, with the maximum number of parallel strings limited to 2. It is paramount that the cable lengths within each string are equal.

Only EnerSys approved components/ parts must be used in conjunction with Hawker XFC product.

STATE OF CHARGE

The open circuit voltage of the individual Hawker XFC bloc prior to installation can be used as an approximate guide to the state of charge (SOC) of the bloc. Figure 2 also shows the influence of storage temperature on the charge retention characteristics.

CAPACITY

The nominal capacity of the Hawker® XFC™ bloc series is rated in Ah at the 5 hour discharge rate [Ah C_5]. Table 2 provides available capacity as function of discharge rates.

Monobloc Type	Capacities / Ah at T = 30°C		
	C_1 (U_{end} = 1.6 Vpc)	C_3 (U_{end} = 1.7 Vpc)	C_5 (U_{end} = 1.7 Vpc)
12XFC25	20.3	23.5	25
12XFC35	28.9	33.6	35
12XFC58	45.8	55.8	58
12XFC82	65	76.5	82
12XFC85	67	80	85
12XFC115	85.2	106.3	115
12XFC130	98.1	120.3	130
12XFC155	117	145.5	155
12XFC158	124	150.6	158
12XFC177	138	168.5	177

Table 2 – Capacity at different discharge rates

TRANSPORTATION

Hawker XFC batteries are classified as "non-spillable wet electric storage batteries" and may be shipped by air or ground transportation without restriction.

Hawker XFC batteries are in compliance with requirements of:
1) US Dept of Transportation - 49 CFR Section 173.159 para d
2) ICAO/IATA Packing Instruction 872, Special Provision A67
3) IMDG Class 8, UN ID 2800 special provisions 238
4) ADR 2011 and RID 2011 Special Provisions 238, 295 and 598

and are classified as Non-spillable and exempt from hazardous goods regulations when securely packed and protected against short circuits.

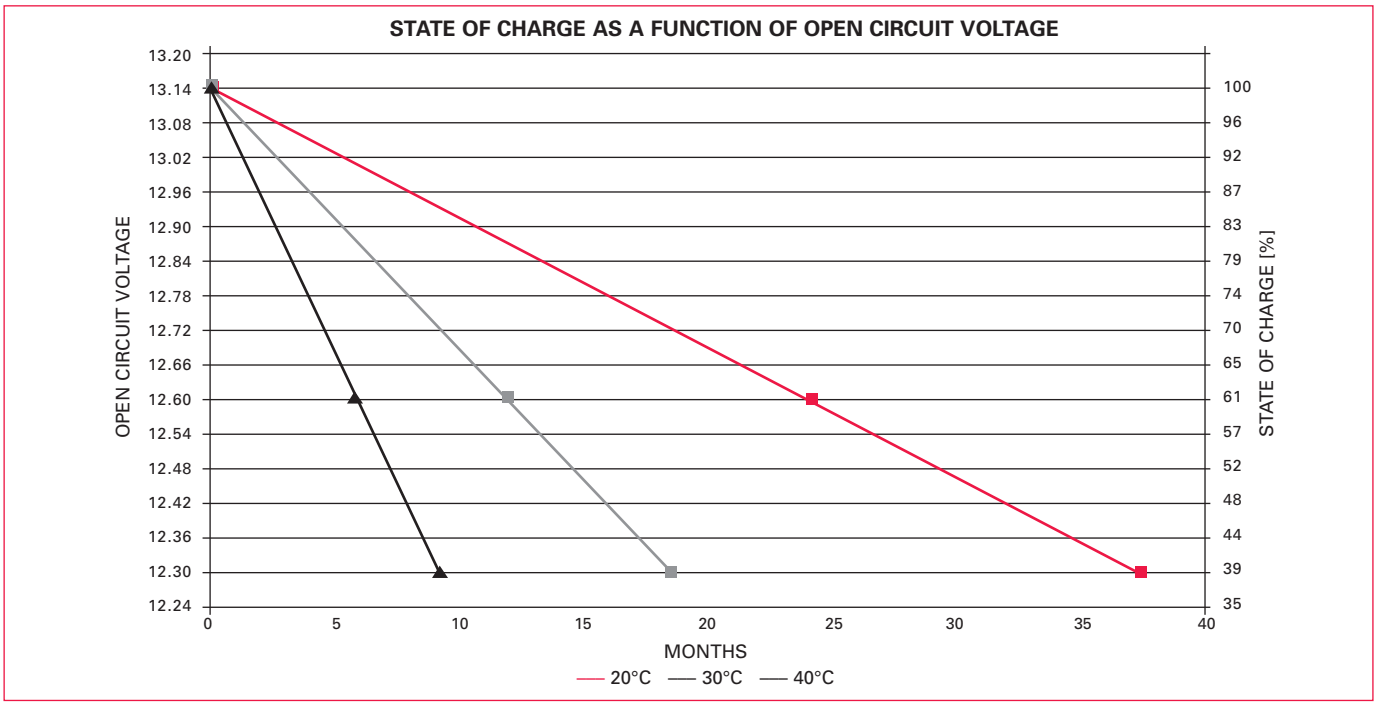


Figure 2 – Open circuit voltages state of charge

STORAGE – INDIVIDUAL HAWKER XFC BLOCS

This data in this section only apply to batteries in storage not fitted to equipment.

Batteries are dispatched from the manufacturer in a fully charged condition. The state of charge will decrease with storage. All batteries lose their stored energy when allowed to stand open-circuit, due to parasitic chemical reactions.

Self- discharge is also strongly influenced by temperature; high temperatures greatly reduce storage life (fig.2 above). It is recommended that the fully charged battery should be stored in a cool dry place, ideally below 20°C.

The battery has a maximum inspection-free storage life of 2 years, if stored at or below 20°C, after which a refresh charge should be administered. However, it is advisable to conduct an inspection and open circuit voltage check after 12 months. If the open circuit voltage falls below 12.6 volts the battery should be recharged using an approved EnerSys® XFC charger.

The battery may be stored for up to 5 years without degradation of performance provided that an open circuit voltage (OCV) check is conducted every 12 months. When stored in temperatures in excess of 30°C (86°F), the battery should be OCV checked every 6 months.

STORAGE – HAWKER XFC BLOCS INSTALLED IN EQUIPMENT

Some equipment will continue to draw very low power loads from the battery when not in service resulting in battery discharge rate greater than shown in figure 2 and described in the previous section. Consequently all sources of electrical power drain must be removed from the battery whilst in transit, storage or extended periods of time out of service. This includes disconnecting the Wi-iQ (if fitted) from the battery.
Failure to comply with the above will result in premature battery failure.

Also refer to comments in opportunity charging section relating to short storage periods between equipment usage.

COMMISSIONING

The Hawker XFC series monoblocs are supplied in a charged condition. The battery should be inspected to ensure it is in perfect physical condition.

Check:

1. The battery cleanliness. Before installing, the battery compartment has to be cleaned.
2. All cables and crimped connectors are in good condition to support high electrical currents.
3. The battery and cables have a good contact to terminals and the polarity is correct. Otherwise the battery, vehicle or charger could be severely damaged.
4. Ensure that all insulation covers are fitted correctly.
5. It is extremely important to ensure the integrity of battery connections. Soldered connections are preferred for battery plugs and post clamps. If soldering is not possible, multi-point crimping must be used.

NOTE: Flexible cable or braid connectors must be used for all monobloc connections. Appropriate fastener kits must be used and approved parts. These can be supplied in EnerSys approved accessory kits. Integral to the fasteners system is an appropriate locking washer – spring or flat washers must not be used.

Connectors must be adequately fastened (see table 3) with the locking washer in place to maintain contact integrity when exposed to operational shock/vibrations.

Monobloc Type	Terminal torque [Nm] Standard Terminal		Terminal torque [Nm] Terminal Adapter	
12XFC25 12XFC35 12XFC85 12XFC115	M6 Female	6.8 Nm	SAE	6.8 Nm
12XFC58 12XFC82	M8 Female	9.0 Nm	Not applicable	
12XFC130 12XFC155	M6 Female	9.0 Nm	Not applicable	
12XFC158 12XFC177	M8 Female	9.0 Nm	M6 Male Front Terminal	9.0 Nm

Table 3 – Torque settings

Use special coding systems for maintenance free batteries for the charging plug-and-socket devices to prevent accidental connection to the wrong type of charger. Never directly connect an electrical appliance (for example: warning beacon) to a part of the battery. This could lead to an imbalance of the cells during the recharge, i.e. a loss of capacity, the risk of insufficient discharge time, damage to the cells and VOIDS THE BATTERY WARRANTY.

Charge the battery before commissioning. Only blocs with the same state of charge should be connected together.

The specified torque loading for the bolts/screws of the end cables and connectors are detailed in the table 3.

OPERATION

DIN EN 50272-3 “Safety requirements for secondary batteries and battery installations. Part 3 traction batteries” is applicable to this product range. The nominal operating temperature is 30°C. The optimum lifetime of the battery depends on the operating conditions (temperature and depth of discharge). The ambient temperature range of use for the battery is between +5°C and +45°C, outside of this range must be approved by the EnerSys Technical department. Optimal battery life is obtained with the battery at a temperature of 25-30°C Higher temperatures shorten the life of the battery (according to IEC1431 technical report), lower temperatures reduce the available capacity. The upper temperature limit is +55°C and batteries should not be operated above this temperature. The capacity of the battery changes with temperature and falls considerably under 0°C. The optimum lifetime of the battery depends on the operating conditions (moderate temperature and moderate depth of discharge – e.g. 40-60% C_5). It is mandatory that the depth of discharge does not exceed 80% of the nominal C_5 capacity. Figure 5 and 6 show relationship between depth of discharge and cycle life.
The battery obtains its full capacity after about 3 charging and discharging cycles.

OPERATING TEMPERATURE

Hawker® XFC™ batteries and EnerSys® approved chargers are designed for use within an ambient temperature range of +5°C to +45°C. For use outside this range, you should consult with EnerSys APPLICATION ENGINEERING AUTHORITY. Applications outside the recommended temperature range will be considered but it will be mandatory to use an EnerSys charger with communication capability (Life iQ™) and the battery must be equipped with Wi-iQ® monitoring device to manage the charge profile in accordance with the battery temperature. The upper temperature limit is +55°C and batteries should not be operated above this temperature.

DISCHARGING

The valves on the top of the battery must not be sealed or covered. Electrical connections (e.g. plugs) must only be made or broken in the open circuit condition. Discharges over 80% of the rated capacity are categorised as deep discharges and are not acceptable as they reduce considerably the life expectancy of the battery. Discharged batteries MUST be recharged immediately and MUST not be left in a discharged condition.

Note: The following statement only applies to partially discharged batteries.

Discharged batteries can freeze.
Limit the discharge to 80% DOD. The presence of a discharge limiter is mandatory and cut-off voltage must be set at the value detailed in table 4, when discharging with currents in the range of $I_{0.5}$ to I_5. At lower currents please seek advice from the EnerSys Application Engineering Authority.

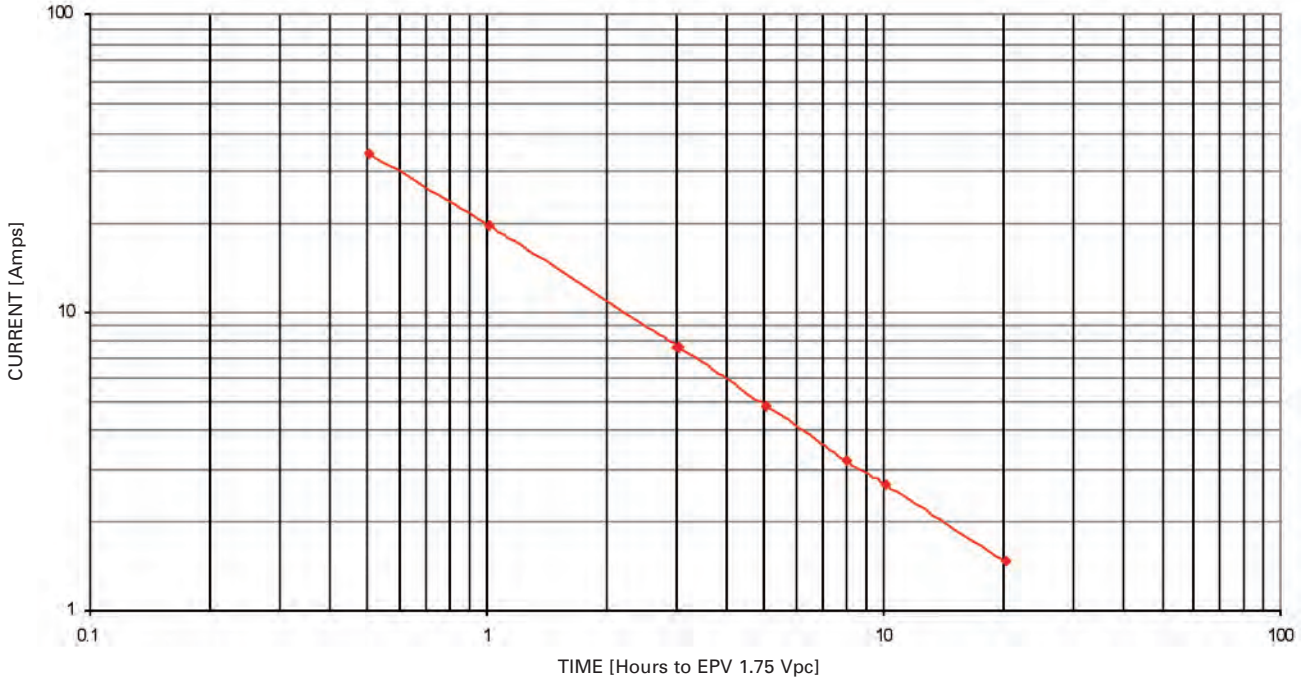
Table 4 - Cut-off voltage limits

	Cut-off voltage setting [Vpc]
60% DOD	1.96 V
80% DOD	1.92 V

DISCHARGE CHARCTERISTICS

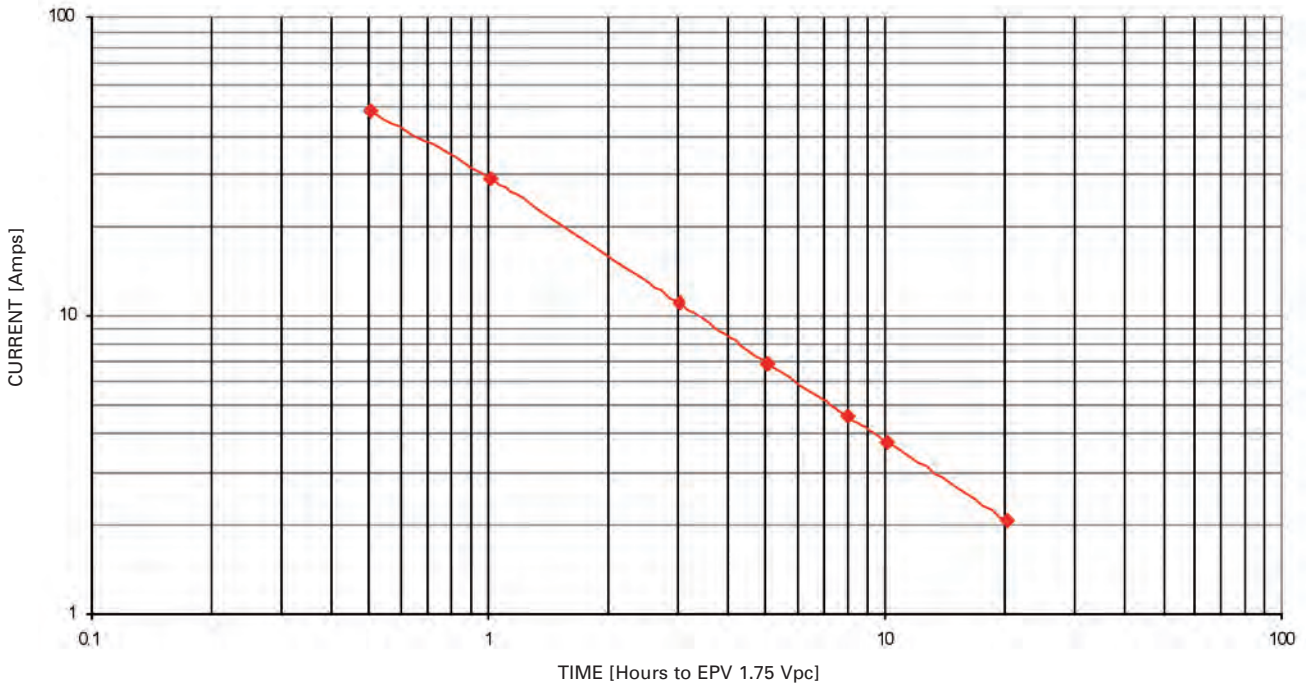
The following graphs show detailed discharge characteristic of the Hawker XFC range to an end point voltage of 1.75Vpc @ 30°C.

12XFC25 PERFORMANCE DATA @ 30°C



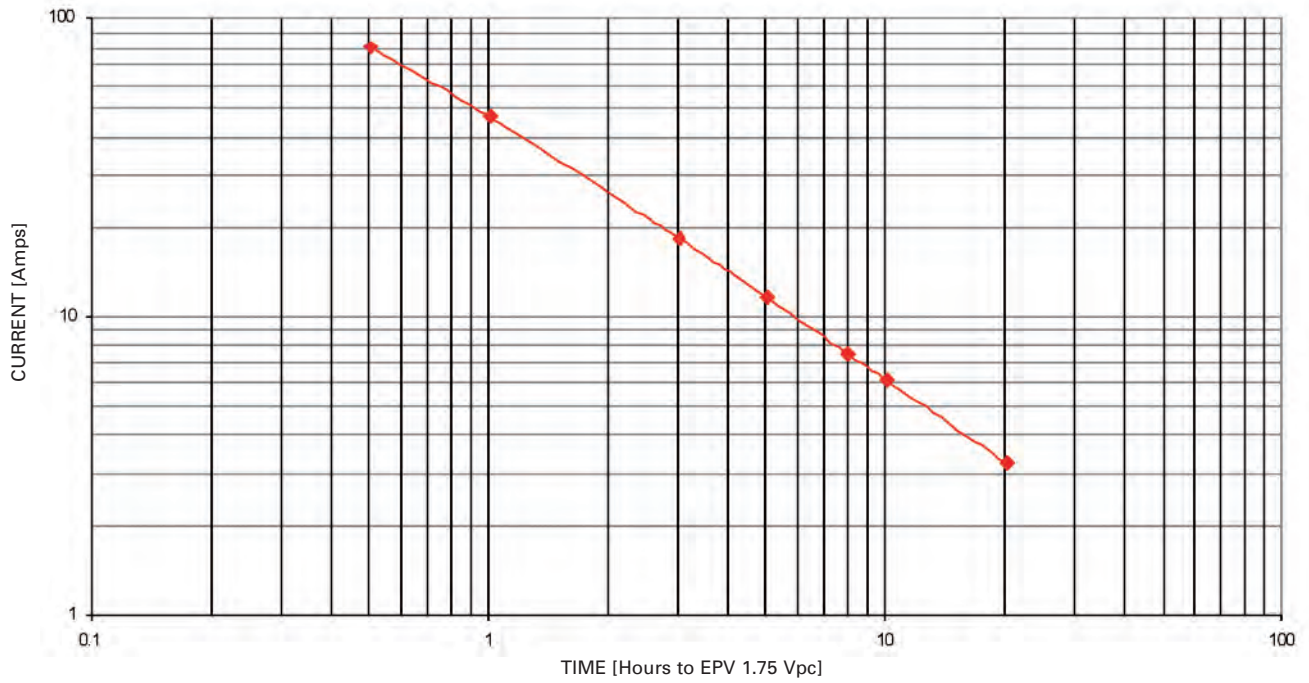
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	34.7	19.9	7.76	4.95	3.21	2.67	1.48

12XFC35 PERFORMANCE DATA @ 30°C



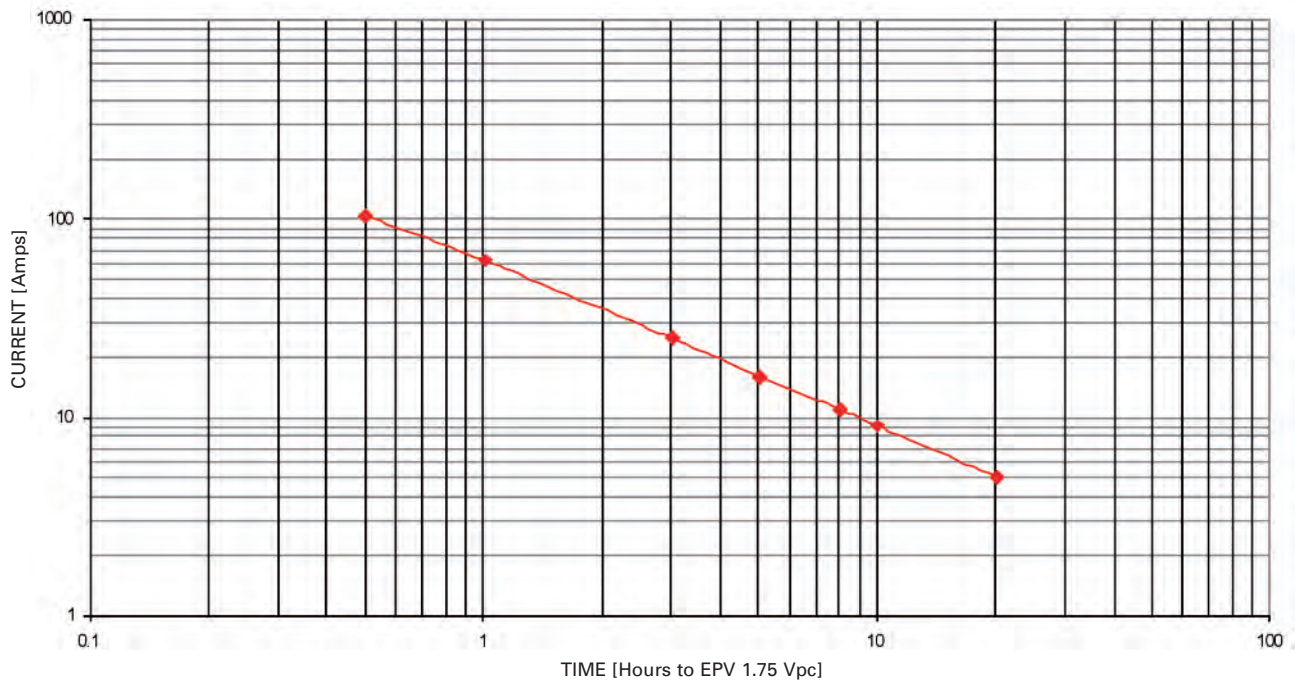
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	48.8	29.3	11.1	7.01	4.65	3.82	2.08

12XFC58 PERFORMANCE DATA @ 30°C



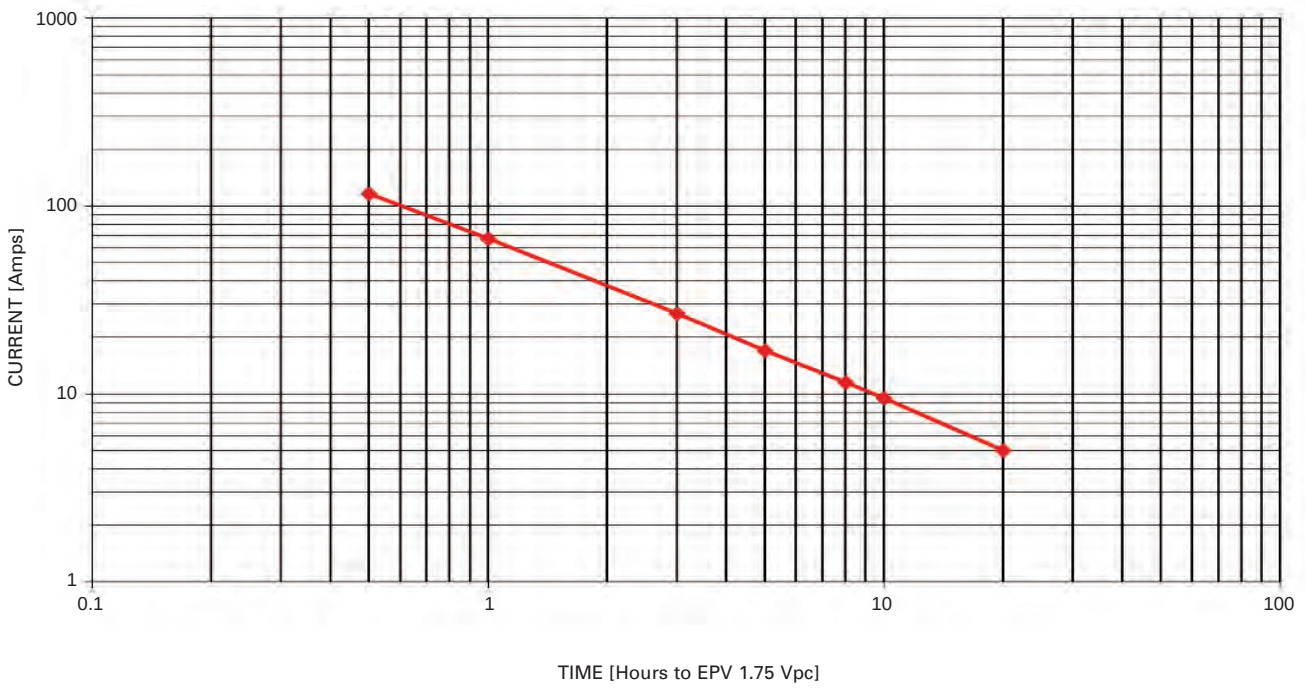
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	80.7	47.4	18.5	11.7	7.59	6.18	3.17

12XFC82 PERFORMANCE DATA @ 30°C



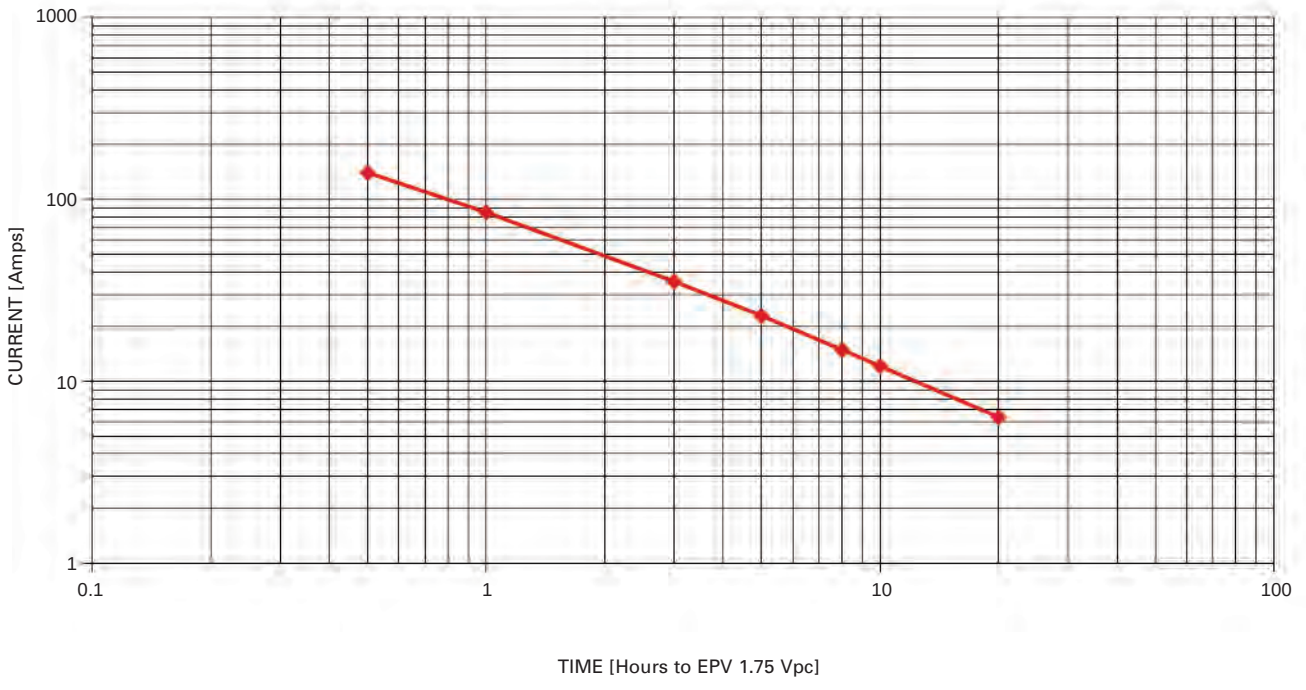
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	105.0	62.7	25.4	16.3	11.2	9.21	5.09

12XFC85 PERFORMANCE DATA @ 30°C



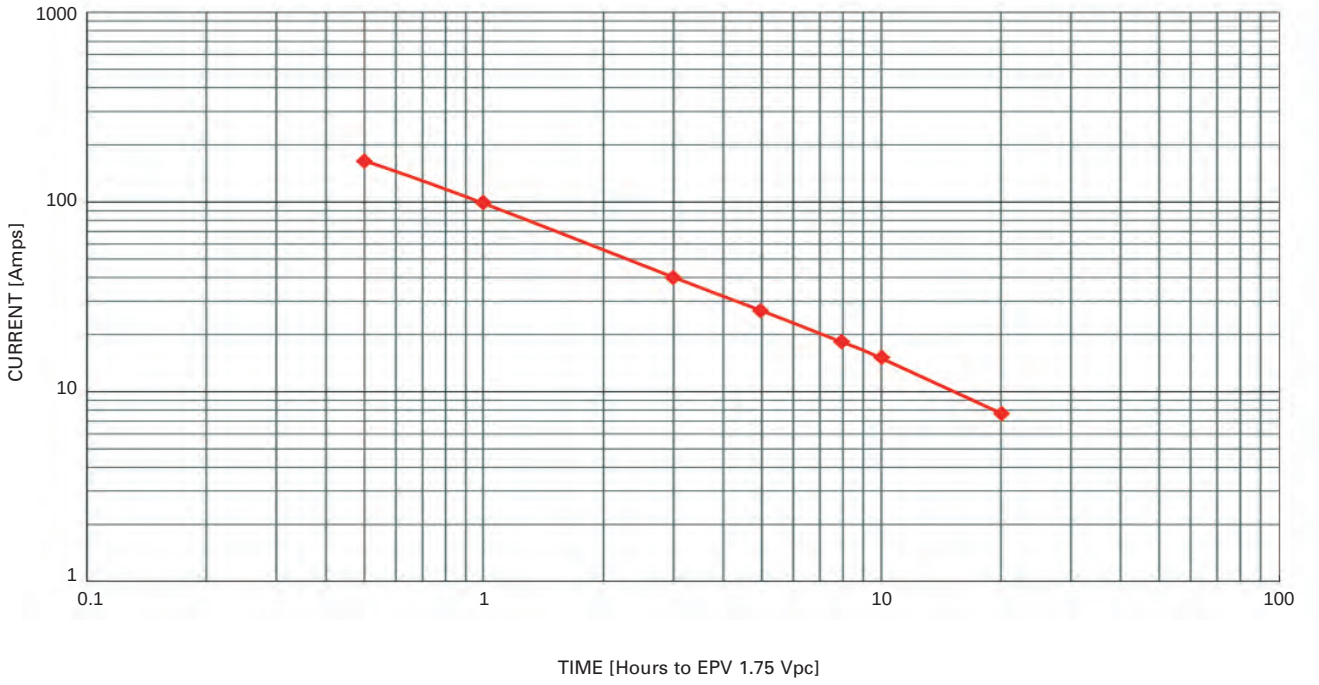
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	116.0	67.0	26.7	17.0	11.5	9.5	5.0

12XFC115 PERFORMANCE DATA @ 30°C



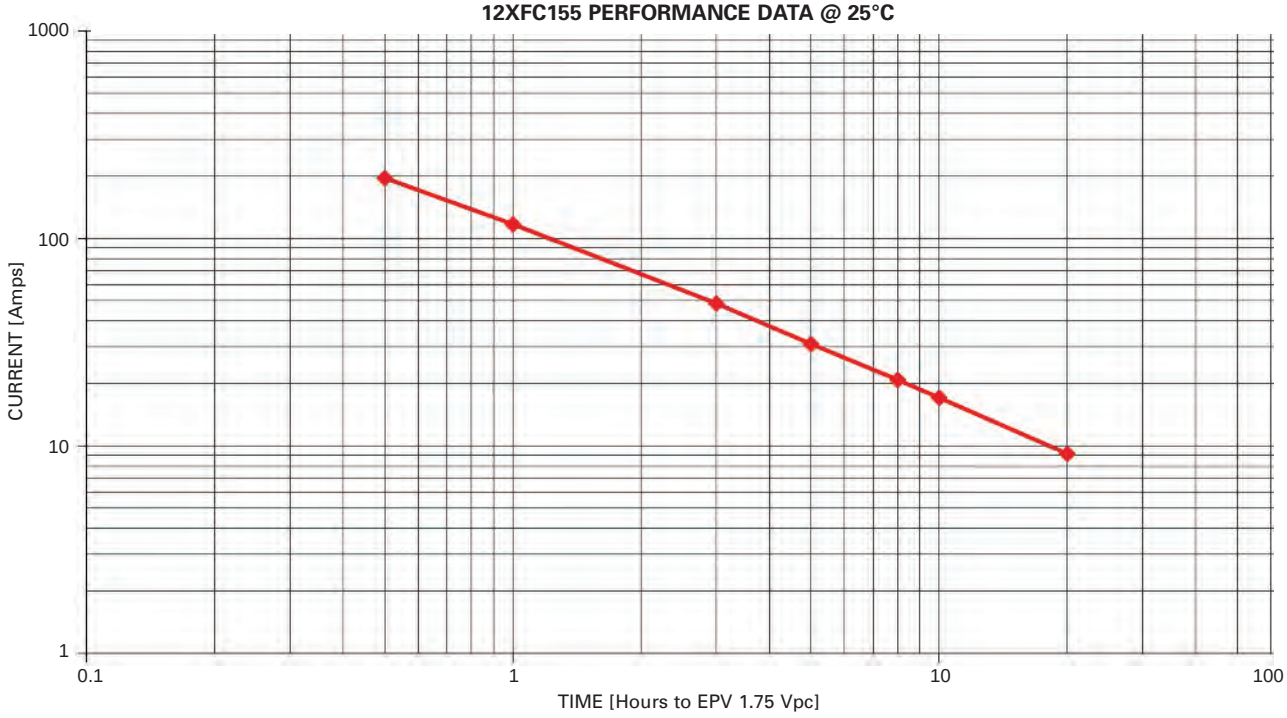
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	140.3	85.2	35.4	23.0	14.9	12.2	6.4

12XFC130 PERFORMANCE DATA @ 25°C



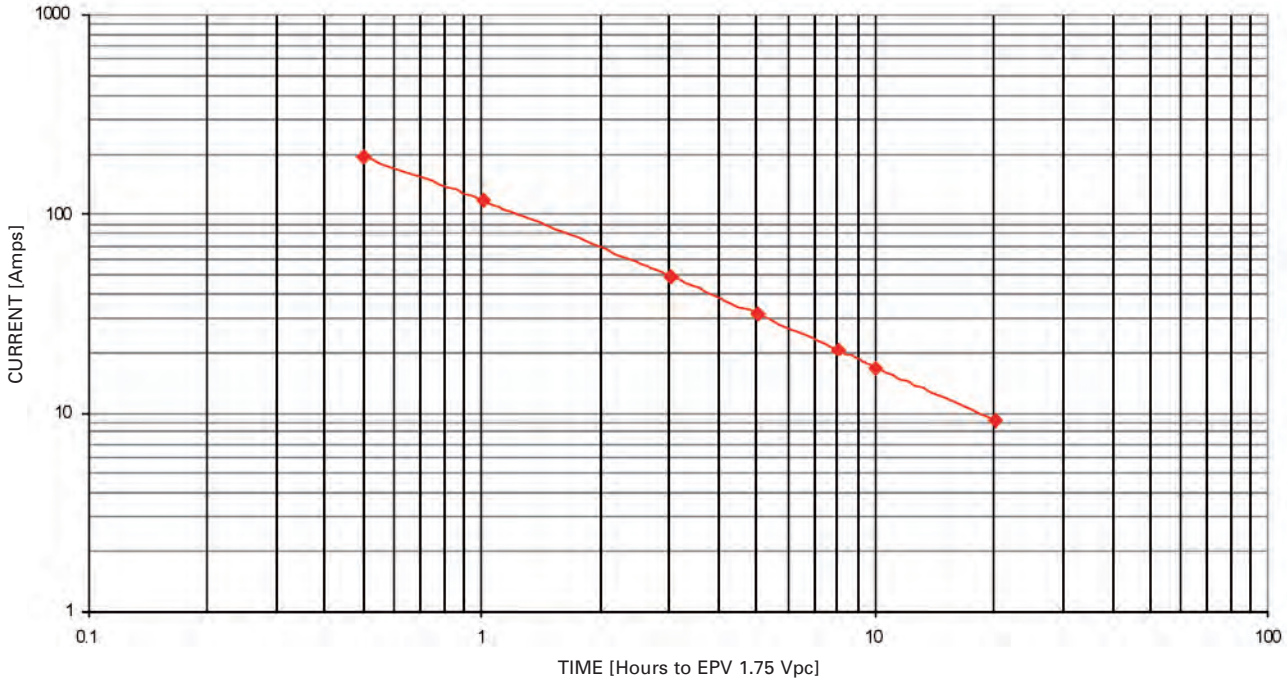
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	165	98.1	40.1	26.7	18.2	15	7.7

12XFC155 PERFORMANCE DATA @ 25°C



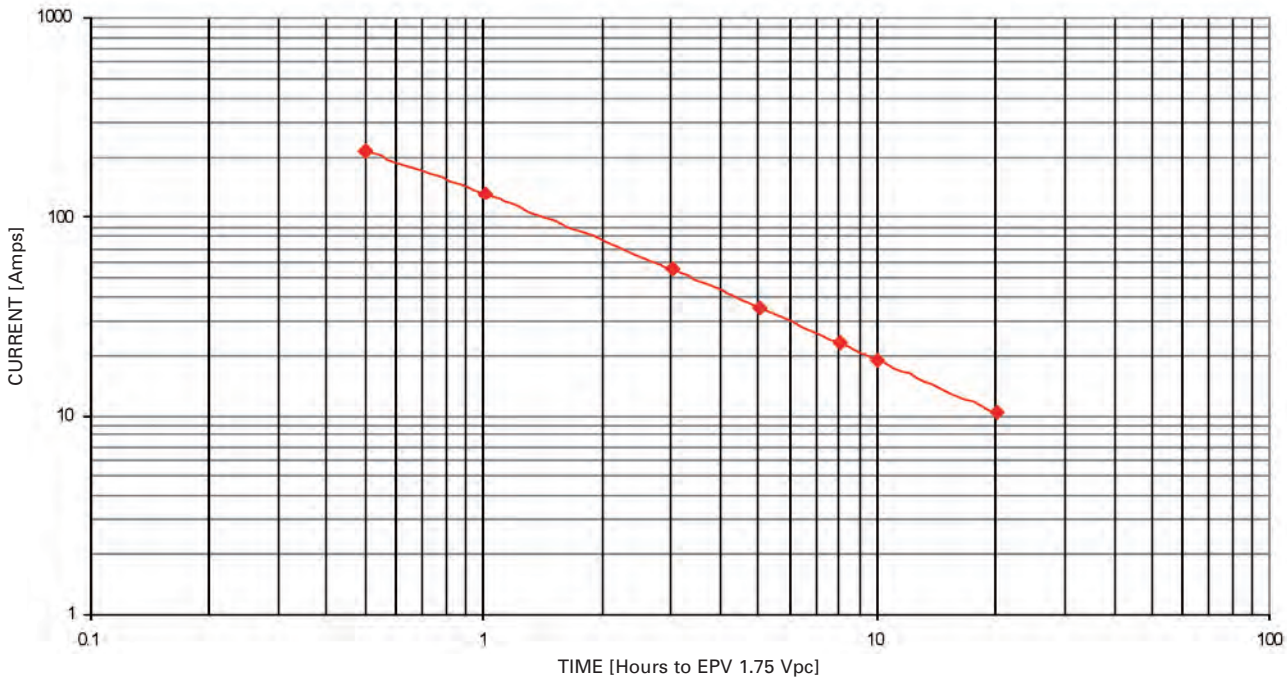
Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	195.00	117.00	48.50	31.00	20.80	17.03	9.16

12XFC158 PERFORMANCE DATA @ 30°C



Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	196.1	120.0	49.5	31.8	21.1	17.2	9.35

12XFC177 PERFORMANCE DATA @ 30°C



Discharge rate [hr]	0.5	1	3	5	8	10	20
Constant current Discharge [A]	217.9	133.5	55.4	35.6	23.6	19.3	10.5

CHARGING

Charging the Hawker® XFC™ batteries correctly is a critical factor to its life expectancy and performance, failure to do so will result in premature failure. To ensure that the Hawker XFC batteries are correctly charged, EnerSys® has developed a fast charge algorithm for cyclic applications to rapidly and safely charge this technology of batteries. EnerSys have a full range of chargers available that can be purchased to be used with your Hawker XFC battery.

Charging must only be carried out where adequate ventilation is available and must not be carried out in confined spaces. Refer to DIN EN 50272-3 section 6.

Hawker XFC batteries can be quickly charged with an approved EnerSys XFC charger. Figures 3 and 4 below show their exceptional fast charge characteristics at varying levels of DOD and inrush currents.

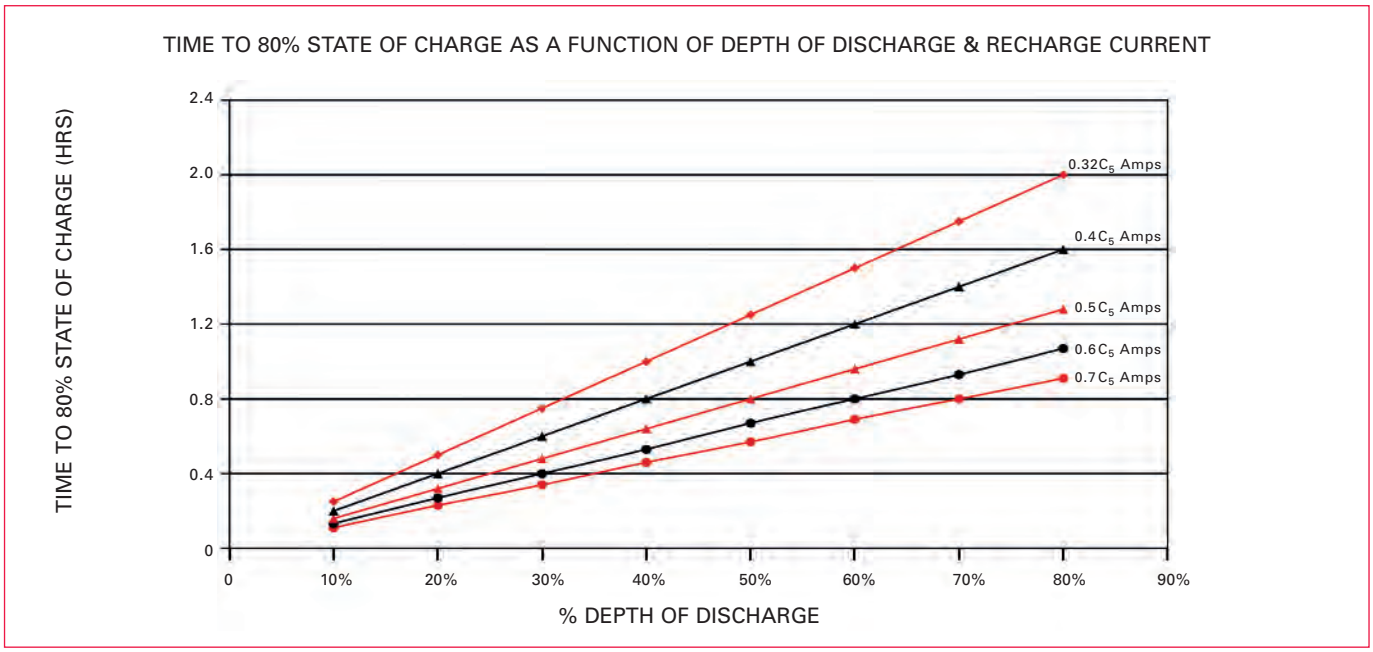


Figure 3 – Recharge time – return 80% of discharged Ah's

As an example, consider a 100Ah battery discharged by 60Ah (to 60% Depth of Discharge), leaving residual capacity of 40Ah. 48Ah will be returned after 0.8hrs of charge with inrush current 0.6C_5A. Battery state of charge after 0.8 hours will be approximately 86% as the recharge process is not 100% efficient.

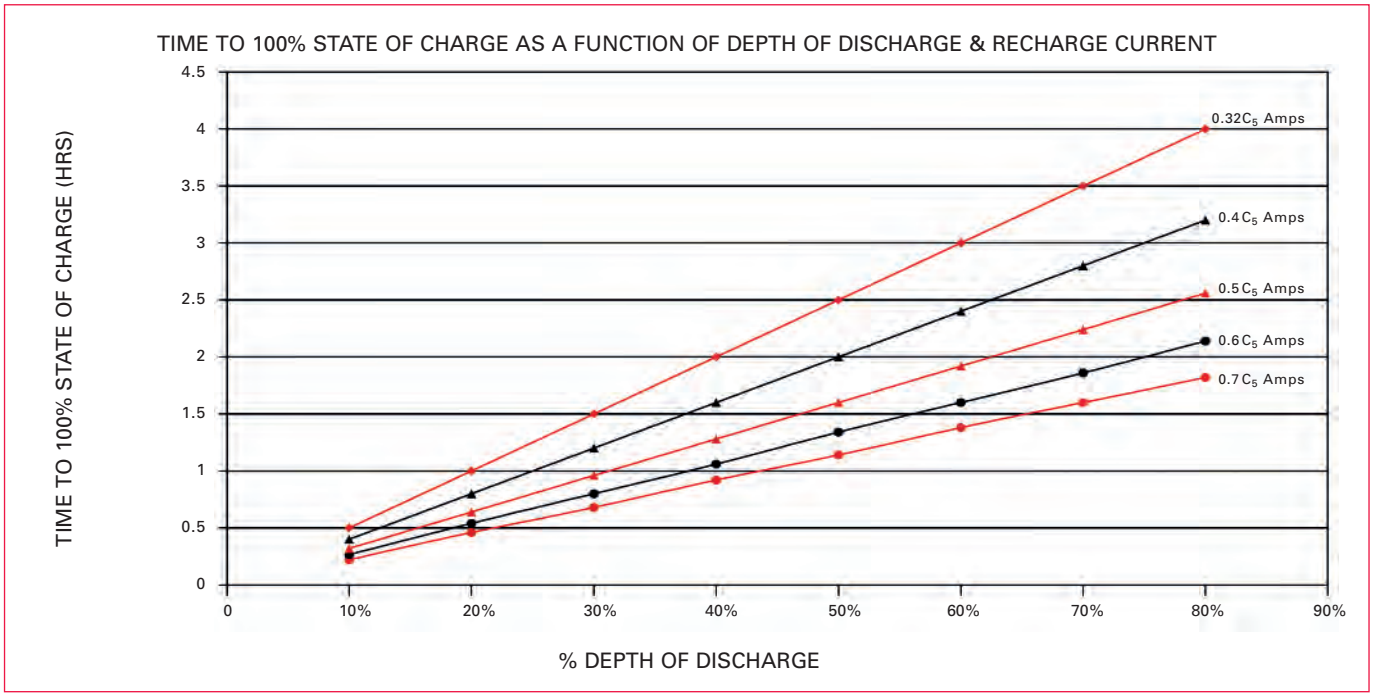


Figure 4 – Recharge time – return 100% of discharged Ah's

Note:
Hawker® XFC™ bloc batteries are designed to be charged with charging rates in range 0.32C_5 to 0.7C_5. Charging at rates outside this range can affect the performance and life expectancy of the battery. Contact EnerSys® before using rates outside this range.

As another example, consider a 100Ah battery discharged by 80Ah (to 80% Depth of Discharge), then recharged with a $0.5C_5$ inrush current, 100% of the discharged Ah (80Ah) will be returned after approximately 2.5h recharge. Increasing inrush current to $0.7C_5$ reduces this to 1.8 hours recharge. The recharge process is not 100% efficient and the battery will achieve approximately 97% state of charge following the above recharge procedure. A short absorption phase after recharging the 100% discharged Ahs is required to ensure full battery recovery. EnerSys chargers are programmed to achieve such recovery and deliver the recharge capabilities shown in Figs 3 and 4.

OPPORTUNITY CHARGING

Hawker® XFC™ batteries are suitable for partial state of charge operation, however the depth of discharge must not exceed 80% of the rated C_5 capacity and opportunity charging must be applied whenever the batteries are not being discharged i.e. break / lunch times, shift handover etc.

Equipment may continue to draw low power loads when not in service, which will reduce available battery capacity. To counter this, EnerSys recommend that the battery/charger remain connected to the main power supply between equipment usage periods. EnerSys approved chargers are designed to counter low power draw and preserve battery state of charge.

The electrochemistry of the Hawker XFC series allows the battery to be recharged in a relatively short period of time with high inrush currents with no detrimental effect. This is possible as a result of its low internal impedance and exceptional charge acceptance.

With these attributes, the SOC of the Hawker XFC battery can be maintained at almost 100% throughout the working day, making the equipment always available for use 24/7.

Note:
It is imperative that the battery receives a complete charge (returning the battery to 100% of its rated C_5 capacity) at least once per week. Failure to do so will have a detrimental effect on the performance and cycle life of the battery.

CYCLE LIFE

The life expectancy of the XFC series depends on the application and its duty cycle.

While several factors affect the life of a battery, cycle life depends primarily on the depth of discharge (DOD).

Depth of Discharge	Cycles
10% DOD	8200
20% DOD	4096
30% DOD	2700
40% DOD	2000
50% DOD	1500
60% DOD	1200
70% DOD	900
80% DOD	700

Figure 5 illustrates this relationship between DOD and cycle life from full state of charge.

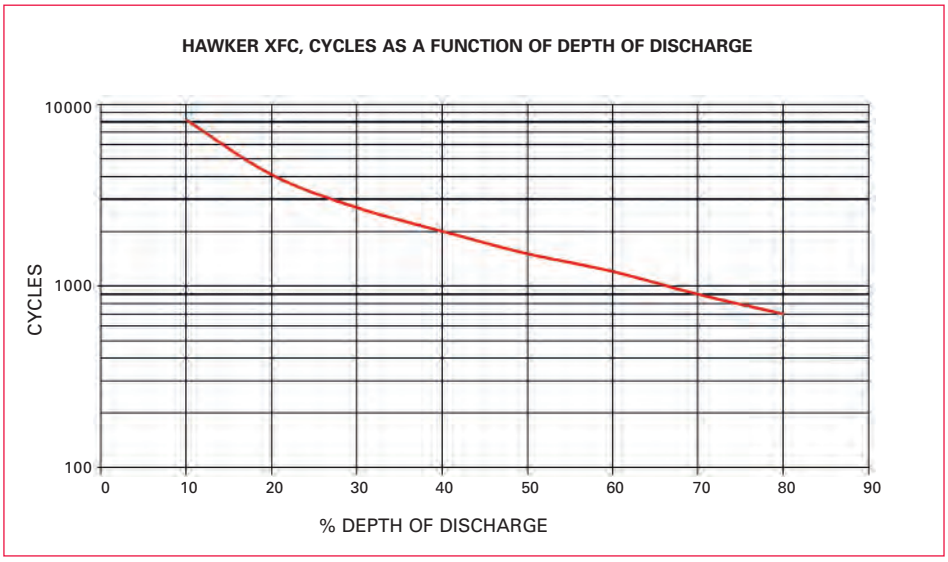


Figure 5 - CYCLE LIFE AS A FUNCTION OF DEPTH OF DISCHARGE 10%-80% (C_5 RATE)

DISPOSAL

Hawker XFC batteries are recyclable. Scrap batteries must be packaged and transported in accordance with prevailing transportation rules and regulations. Scrap batteries must be disposed of in compliance with local and national laws by a licensed or certified lead acid battery recycler.

Wherever you do business, EnerSys® can support you with motive power energy. The Hawker® branded battery range, matched chargers and systems provide trouble free performance under the most demanding service conditions. 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. The recently developed energy solutions: IRONCLAD® and Hawker XFC™ batteries, Lifetech®, Life iQ™ and LifeSpeed iQ™ HF modular chargers, have defined new benefits for our customers: faster recharge, more machine availability, lower operating and investment costs, reduced carbon footprint. 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 market fast.

EnerSys's integrated sales and service network is dedicated to providing our customers with the best solutions and after-sales support for their business. Whether you require 1 battery or a complete fleet of batteries, chargers, a battery handling system and a state of the art fleet management system, you can count on us. EnerSys is the world's largest industrial battery manufacturer and we are dedicated to being the best.

EnerSys
Power/Full Solutions

EnerSys EMEA
EH Europe GmbH
Löwenstrasse 32
8001 Zürich
Switzerland
Phone: +41 44 215 74 10
Fax: +41 44 215 74 11

Local contact:

Enersys Ltd
Oak Court
Clifton Business Park
Wynne Avenue
Swinton
Manchester M27 8FF
Phone: 0161 794 4611
Fax: 0161 727 3809

Please refer to the website address for details of your nearest EnerSys office:
www.enersys-emea.com

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