TPPL TECHNOLOGY

NexSys® TPPL

NEXSYS® TPPL BATTERIES

SAFETY, INSTALLATION, OPERATION, MAINTENANCE,
TROUBLESHOOTING AND SERVICE INSTRUCTIONS

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EnerSys® Power/Full Solutions

TABLE OF CONTENTS

INTRODUCTION

Since their introduction in the early 1990s, Thin Plate Pure Lead (TPPL) blocs have been established as a premium high performance bloc 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.

NexSys® TPPL blocs use the principles of advanced TPPL technology to achieve exceptionally high performance, energy density and cycling capability. These characteristics make the NexSys TPPL battery range ideal for use in motive power applications such as floor care, pallet trucks, Automated Guided Vehicles (AGVs), personnel carriers and utility vehicles.

This manual describes the NexSys TPPL bloc range, physical characteristics and the basic information on storage, operation and maintenance.

SAFETY PRECAUTIONS

Motive power blocs for small traction Valve Regulated Lead Acid (VRLA) NexSys TPPL battery series: TPPL technology.

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

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

- Pay attention to the operating instructions and keep them close to the bloc.
- Work on blocs must only be carried out by skilled personnel!

- Use protective glasses and wear safety clothing when working on blocs.
- Adhere to the current accident prevention rules in the country where the blocs is used or DIN EN 50272-3, DIN EN 50110-1.

- Keep children away from batteries!

- No smoking!
- Do not expose blocs 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 immobilized 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: NexSys TPPL batteries are capable of high short circuit currents.
- Caution — metal parts of the batteries 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.

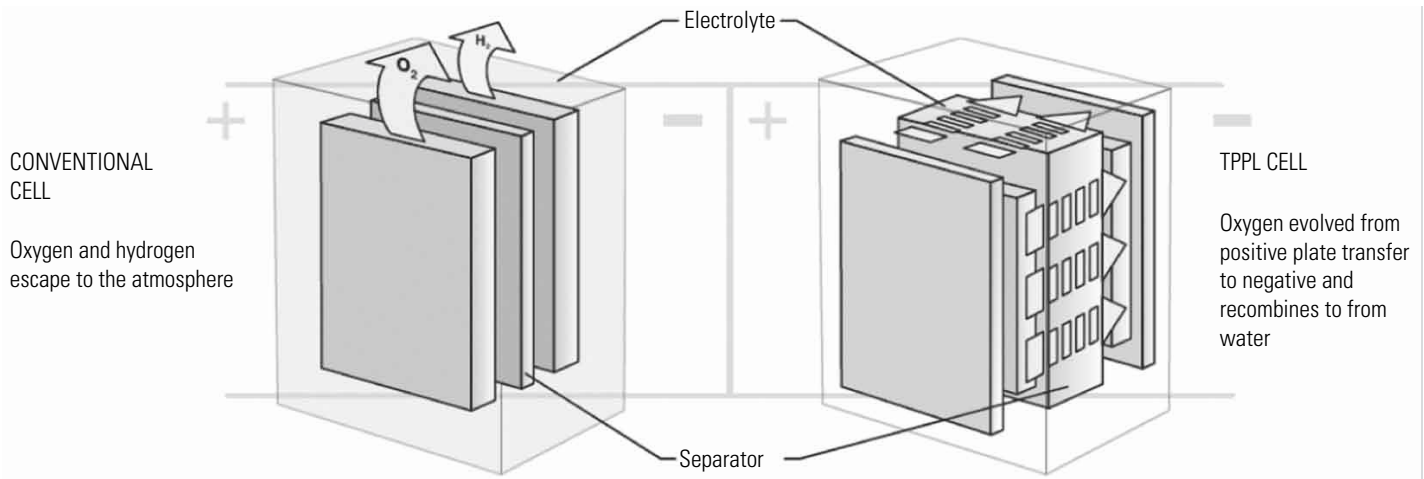
RECOMBINATION TECHNOLOGY

Conventional flooded lead acid batteries require an equalization overcharge to preserve capacity over time. During this overcharge process, hydrogen and water is lost from the cell due to a process called electrolysis. Therefore, regular watering of the cell is required, along with the need for cleaning excess acid overflow. And resulting hydrogen emissions are subjected to strict regulations to avoid dangerous concentration.

Because of their Valve Regulated Lead Acid (VRLA) technology, NexSys® TPPL blocs eliminate the need for watering and battery cleaning. The VRLA technology limits the evolution of oxygen and hydrogen gasses through an internal process called "gas recombination." During charging, immobilized acid in the glass mat retains gasses produced from escalating through the electrolyte. Oxygen and hydrogen released during the charging reaction are reconverted back to water by the negative plates. If this process was 100% efficient, no water would be lost from the cell; but as a result of carefully designed cell constituents, up to 99% gas recombination is achieved, therefore eliminating the need for battery watering after charging.

As recombination is never 100%, some hydrogen gas is emitted from NexSys TPPL blocs through the self-regulating valve; the lgas value for this technology of bloc is 1.5A/100 Ah C_5/C_6.

Principle of the Oxygen Reduction Cycle



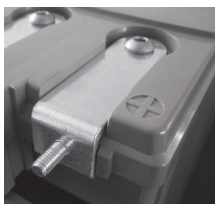
BLOC SUMMARY

RANGE SUMMARY

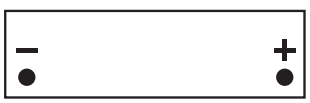
Table 1 - NexSys® TPPL battery specifications

Monobloc Type	Nominal Voltage	Nominal Capacity	KW rating	Dimensions				Weight	No. of Cycles	Terminal Type	Terminal Layout
				L	W	Box Height	Terminal Height				
	V	C6		in	in	in	in	lbs			
12NXP26	12	26	0.057	9.84	3.82	5.79	5.67	21.1	1200	M6 Female	1
12NXP36	12	36	0.081	9.84	3.82	7.76	7.64	29.0	1200	M6 Female	1
12NXP38	12	38	0.096	7.74	6.5	6.69	6.37	38.4	1200	M6 Female	1
12NXP50	12	50	0.111	8.66	4.76	9.92	9.76	41.1	1200	M6 Female	1
12NXP61	12	61	0.135	11.02	3.82	10.39	9.76	42.0	1200	M8 Female	1
12NXP62	12	62	0.146	12.95	6.54	6.85	6.54	53.2	1200	M6 Female	1
12NXP85	12	85	0.188	15.55	4.13	10.39	9.76	60.0	1200	M8 Female	2
12NXP89	12	89	0.215	12.99	6.79	8.43	8.62	77.4	1200	3/8- 16" Female	1
12NXP120	12	120	0.270	13.31	6.81	10.71	10.75	94.8	1200	M6 Female	1
12NXP137	12	137	0.320	16.90	6.79	9.36	9.36	105.0	1200	M6 Female	2
12NXP158	12	158	0.365	16.90	6.79	10.75	10.75	117.0	1200	M6 Female	2
12NXP166	12	166	0.367	22.09	4.92	11.14	10.35	113.3	1200	M8 Female	2
12NXP186	12	186	0.411	22.09	4.92	12.48	11.69	131.1	1200	M8 Female	2

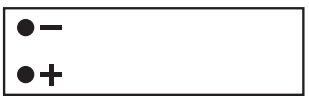
Option A: SAE post



Option B: M6 male front terminal adapter



Terminal layout 1



Terminal layout 2

Note: Flexible connectors must be used for all monobloc connections. EnerSys® approved fasteners must be used.

ORIENTATION

NexSys® TPPL blocs can be mounted in any orientation except inverted.

BLOC CONFIGURATIONS

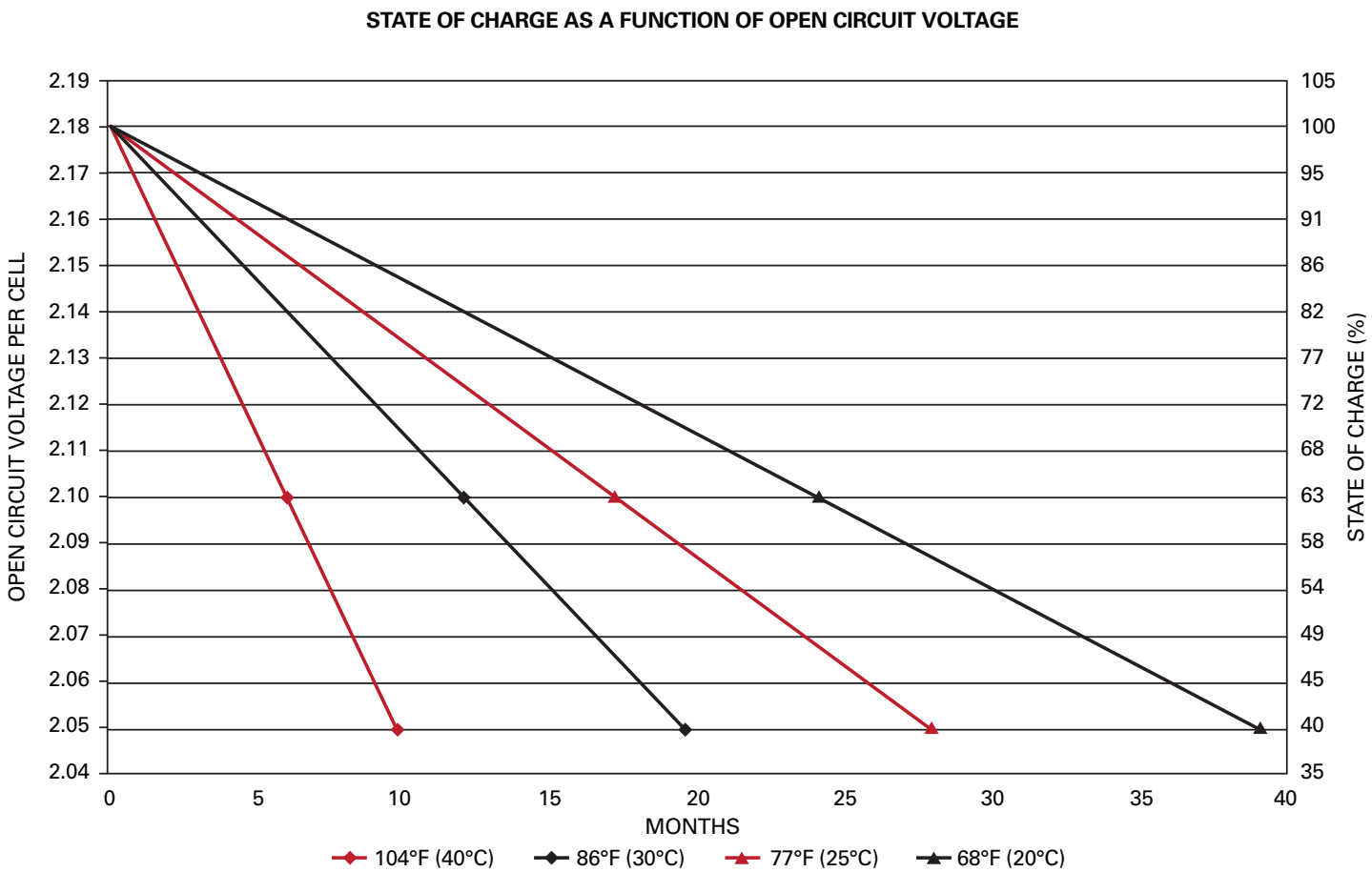
NexSys TPPL blocs may be configured into a bloc comprising series/parallel strings, with the maximum number of parallel strings limited to 3. It is paramount that the cable lengths within each string are equal.

Only EnerSys® approved components/parts must be used in conjunction with NexSys TPPL battery product.

STATE OF CHARGE

The open circuit voltage of the individual NexSys TPPL bloc prior to installation can be used as an approximate guide to the State of Charge (SOC) of the bloc. *Figure 1* also shows the influence of storage temperature on the charge retention characteristics.

Figure 1



STORAGE – INDIVIDUAL NEXSYS TPPL BLOCS

The data in this section only apply to blocs 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 (*Figure 1*, as above). It is recommended that the fully charged battery should be stored in a cool dry place, ideally below 68ºF (20ºC), but no lower than 41ºF (5ºC).

Note: Battery must be charged before use. Refer to Charging section on page 11 for more details.

STORAGE – NEXSYS® TPPL BLOCS INSTALLED IN EQUIPMENT

Some equipment will continue to draw very low power loads from the bloc when not in service. This results in bloc self discharge rates greater than shown in Figure 1 and described in the previous section. Consequently, all sources of electrical power drain must be removed from the bloc whilst in transit, storage devise or extended periods of time out of service. This includes disconnecting the Wi-iQ® device (if fitted) and POD™ device from the bloc.

Failure to comply with the above will result in premature bloc failure and will render the warranty void. Also refer to comments in the opportunity charging section (p.13) relating to short storage periods between equipment usage.

Note: Battery must be charged before use. Refer to Charging section on page 11 for more details.

CAPACITY

The nominal capacity of the NexSys® TPPL bloc series is rated in Ah at the 6 hour discharge rate. *Table 2* provides these ratings and additional C_1 and C_3 capacity discharge ratings.

Table 2 - NexSys® TPPL Battery Capacity

Monobloc Type	Nominal Capacity [Ah] 77°F (25°C)		
	C_1	C_3	C_6
12NXP26	19.3	22.6	26
12NXP36	28.5	32.3	36
12NXP38	32.3	38.5	38
12NXP50	36.5	44.0	50
12NXP61	46.1	53.9	61
12NXP62	51.2	58.9	62
12NXP85	60.9	74.0	85
12NXP89	74.6	86.5	89
12NXP120	85.2	106.2	120
12NXP137	108.5	128.6	137
12NXP158	117.0	145.5	158
12NXP166	116.6	144.3	166
12NXP186	129.8	161.5	186

TRANSPORTATION

NexSys TPPL blocs are classified as "non-spillable wet electric storage blocs" and may be shipped by air or ground transportation without restriction.

NexSys TPPL blocs 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

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

The bloc has a maximum inspection-free storage life of 18 months, if stored at or below 68°F (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 bloc should be recharged using an approved EnerSys® NexSys®+ or Delta-Q IC1200 or IC650 charger with approved firmware.

COMMISSIONING

The NexSys® TPPL series blocs are supplied in a charged condition. The bloc should be inspected to ensure it is in perfect physical condition.

Check:

1. The bloc cleanliness. Before installing, the bloc compartment has to be cleaned.
2. All cables and crimped connectors are in good condition to support high electrical currents.
3. The bloc and cables have a good contact to terminals and the polarity is correct. Otherwise the bloc, 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 bloc connections. Soldered connections are preferred for bloc plugs and post clamps. If soldering is not possible, multi-point crimping must be used.

NOTE: Flexible cable or braided 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.

Table 3 – Torque Settings

Monobloc Type	Terminal Torque			Terminal Torque Adapter Terminal		
		Nm	lbf in		Nm	lbf in
12NXP26	M6 Female	6.8	60	SAE	6.8	60
12NXP36	M6 Female	6.8	60	SAE	6.8	60
12NXP38	M6 Female	6.8	60	SAE	6.8	60
12NXP50	M6 Female	6.8	60	SAE	6.8	60
12NXP61	M6 Female	9.0	80		Not Applicable	
12NXP62	M6 Female	6.8	60	SAE	6.8	60
12NXP85	M6 Female	9.0	80		Not Applicable	
12NXP86	3/8- 16" Female	6.8	60	SAE	6.8	60
12NXP90	M8 Female	6.8	60	SAE	6.8	60
12NXP120	M8 Female	6.8	60	SAE	6.8	60
12NXP137	M8 Female	6.8	60	M6 Male Front Terminal	9.0	80
12NXP157	M8 Female	6.8	60			
12NXP166	M8 Female	9.0	80			
12NXP186	M8 Female	9.0	80			

Use special coding systems for maintenance free blocs 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 bloc. 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 BLOC WARRANTY.

Charge the bloc per the guidelines set forth in the "Charging" section of this document 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 *Table 3*.

OPERATION

EN 62485-3 "Safety requirements for secondary batteries and battery installations- Part 3: Traction batteries" and IEC 62485 "Safety requirements for secondary batteries and battery installations – Part 3: Traction batteries" are applicable to this product range. The nominal operating temperature is 77°F (25°C). The optimum lifetime of the bloc depends on the operating conditions (temperature and Depth of Discharge (DOD).

The acceptable temperature range for the discharge of NexSys® TPPL battery products is between-20°F (-29°C) and 113°F (45°C). Optimal bloc life is obtained with the bloc at a temperature between 77°F (25°C) and 86°F (30°C). Higher temperatures shorten the life of the bloc (according to IEC 1431 technical report), lower temperatures reduce the available capacity. The upper discharge temperature limit is 113°F (45°C) and blocs should not be operated above this temperature. The capacity of the battery changes with temperature and falls considerably under 32°F (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/C_6). It is mandatory that the DOD does not exceed 80% of the nominal C_5 or C_6 capacity. *Figure 4* and *Table 8* show relationship between DOD and cycle life.

The battery obtains its full capacity after about three charging and discharging cycles.

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 (NexSys®+) and the battery must be equipped with Wi-iQ® monitoring device to manage the charge profile in accordance with the battery temperature.

DISCHARGING

The valves on the top of the bloc must not be sealed or covered. Electrical connections (e.g. plugs) must only be made or broken in the open circuit condition. Discharges over 60% of the rated capacity are categorized as deep discharges and are not acceptable as they reduce considerably the life expectancy of the bloc. Discharged blocs MUST be recharged immediately and MUST not be left in a discharged condition.

NOTE: The following statement only applies to partially discharged blocs.

Discharged blocs can freeze.

Limit the daily discharge to 60% 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

Depth of Discharge	Cut-off Voltage Setting
	Vpc
50%	1.98
60%	1.96

DISCHARGE CHARACTERISTICS

The following table shows discharge characteristics of the NexSys® TPPL battery range to an end point voltage of 1.75Vpc @ 77°F (25°C) and 1.70Vpc @ 86°F (30°C). See *Tables 5 and 6* below.

Table 5 – Constant Current Discharge Table @ 86°F (30°C)

	Constant Current Discharge (A) 1.7Vpc @ 86°F (30°C)						
Model	**20**	**10**	**8**	**5**	**3**	**1**	**0.5**
12NXP26	1.53	2.81	3.41	5.21	8.21	21.28	37.55
12NXP36	2.06	3.83	4.68	7.18	11.34	29.17	50.77
12NXP38	2.10	4.00	4.92	7.59	12.03	31.09	54.39
12NXP50	2.87	5.35	6.54	10.02	15.77	39.86	68.63
12NXP61	3.38	6.41	7.88	12.20	19.45	50.65	87.66
12NXP62	3.55	6.71	8.20	12.42	19.50	49.94	88.73
12NXP85	5.27	9.43	11.37	16.99	26.41	66.25	113.52
12NXP86	5.17	9.47	11.55	17.46	27.95	73.65	130.81
12NXP90	4.97	9.44	11.55	18.02	28.42	72.32	127.60
12NXP120	6.84	12.58	15.55	23.98	38.18	98.98	171.63
12NXP137	7.87	15.31	18.61	27.38	41.25	102.34	174.46
12NXP157	9.43	17.47	21.41	31.40	50.31	126.17	207.83
12NXP166	9.56	17.80	21.74	33.20	51.89	126.87	211.52
12NXP186	10.80	20.04	24.50	37.22	58.28	142.71	236.05

Table 6 – Constant Current Discharge Table @ 77°F (25°C)

	Constant Current Discharge (A) 1.75Vpc @ 77°F (25°C)						
Model	**20**	**10**	**8**	**5**	**3**	**1**	**0.5**
12NXP26	1.48	2.72	3.29	4.27	7.88	20.31	35.62
12NXP36	2.04	3.77	4.59	5.97	11.10	28.36	49.10
12NXP38	2.04	3.86	4.75	6.19	11.50	29.63	51.37
12NXP50	2.78	5.21	6.36	8.26	15.20	38.22	65.41
12NXP61	3.33	6.30	7.73	10.10	18.90	48.40	82.62
12NXP62	3.48	6.55	8.00	10.30	18.90	48.14	85.24
12NXP85	5.16	9.20	11.10	14.10	25.50	62.78	106.00
12NXP86	5.02	9.19	11.20	14.40	27.10	71.50	127.00
12NXP90	4.79	9.44	11.50	15.00	28.10	70.52	123.00
12NXP120	6.54	12.40	15.30	20.00	37.40	95.83	164.10
12NXP137	7.61	14.80	18.00	22.80	39.70	96.97	162.80
12NXP157	9.20	17.00	20.80	26.17	48.50	120.00	195.00
12NXP166	9.33	17.30	21.10	27.66	50.00	120.70	198.50
12NXP186	10.50	19.50	23.80	31.00	56.20	135.60	221.60

KILOWATT HOUR RATINGS

The following table shows kilowatt hour ratings at different discharge rates of the NexSys® TPPL battery range to an end point voltage of 1.75Vpc @ 77°F (25°C).

See *Table 7* below.

Table 7– Kilowatt Hour Rating

	KWh Rating 1.75Vpc — C_5 @ 86°F (30°C) or C_6 @ 77°F (25°C)							
Model	**0.5**	**1**	**3**	**5**	**6**	**8**	**10**	**20**
12NXP26	0.214	0.244	0.283	0.301	0.307	0.316	0.326	0.356
12NXP36	0.295	0.341	0.398	0.422	0.430	0.442	0.452	0.490
12NXP38	0.308	0.355	0.415	0.438	0.445	0.456	0.463	0.488
12NXP50	0.392	0.458	0.548	0.583	0.594	0.611	0.625	0.668
12NXP61	0.496	0.581	0.680	0.714	0.725	0.742	0.756	0.799
12NXP62	0.511	0.577	0.682	0.725	0.742	0.768	0.786	0.835
12NXP85	0.636	0.754	0.917	0.989	1.015	1.064	1.104	1.238
12NXP86	0.762	0.858	0.977	1.027	1.038	1.076	1.103	1.204
12NXP90	0.738	0.846	1.010	1.070	1.082	1.104	1.133	1.148
12NXP120	0.984	1.150	1.346	1.415	1.440	1.472	1.489	1.570
12NXP137	0.977	1.164	1.428	1.584	1.643	1.726	1.774	1.826
12NXP157	1.170	1.440	1.746	1.809	1.884	1.997	2.040	2.208
12NXP166	1.190	1.448	1.801	1.952	1.992	2.028	2.078	2.239
12NXP186	1.330	1.627	2.022	2.117	2.232	2.284	2.338	2.531

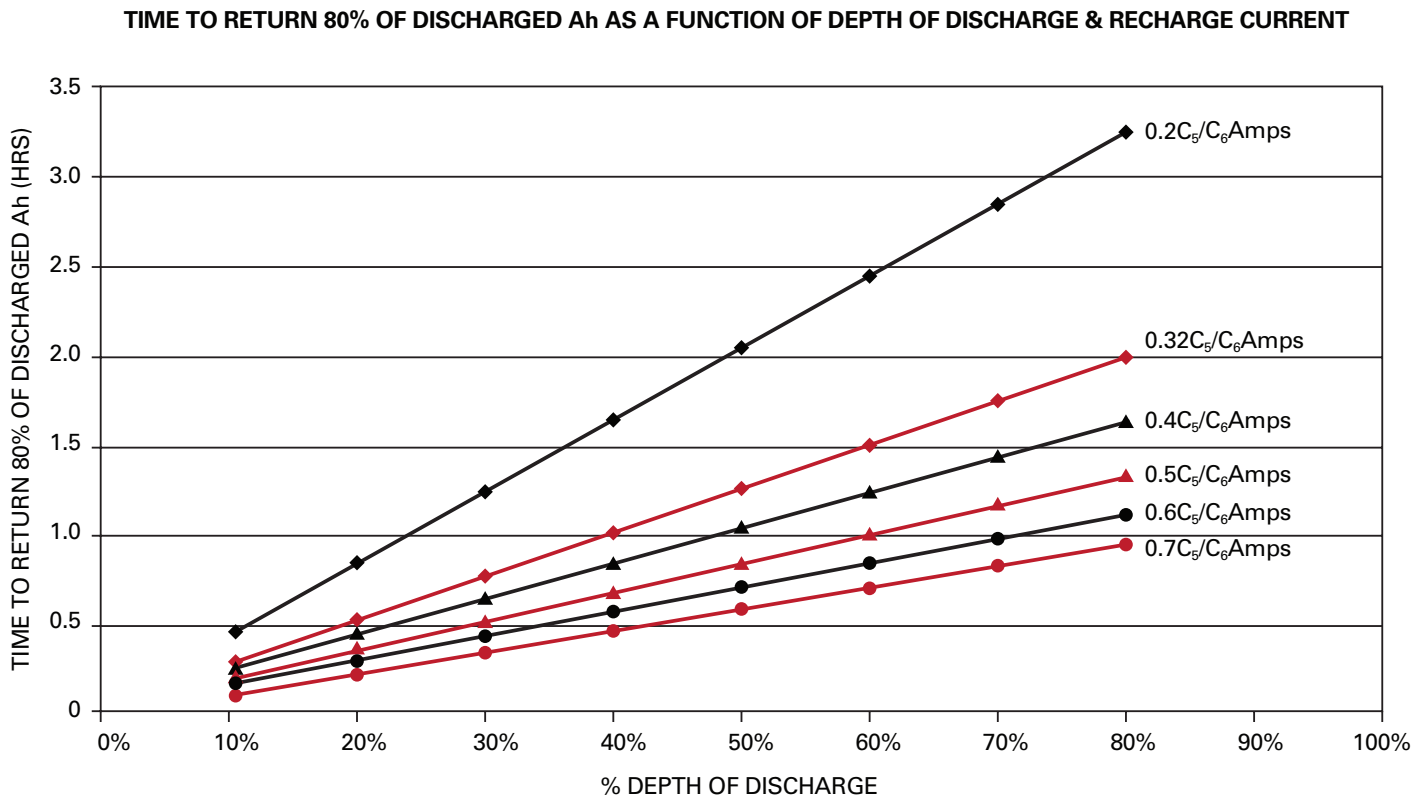
CHARGING

Charging the NexSys TPPL blocs correctly is a critical factor to their life expectancy and performance. Failure to do so will result in premature failure. To ensure that the NexSys TPPL blocs are correctly charged, EnerSys® has developed a fast charge algorithm for cyclic applications to rapidly and safely charge this technology of blocs. EnerSys has a full range of chargers available that can be purchased to be used with your NexSys TPPL bloc.

The acceptable charging temperature range is between 32°F (0°C) and 113°F (45°C). Charging must only be carried out where adequate ventilation is available and must not be carried out in confined spaces.

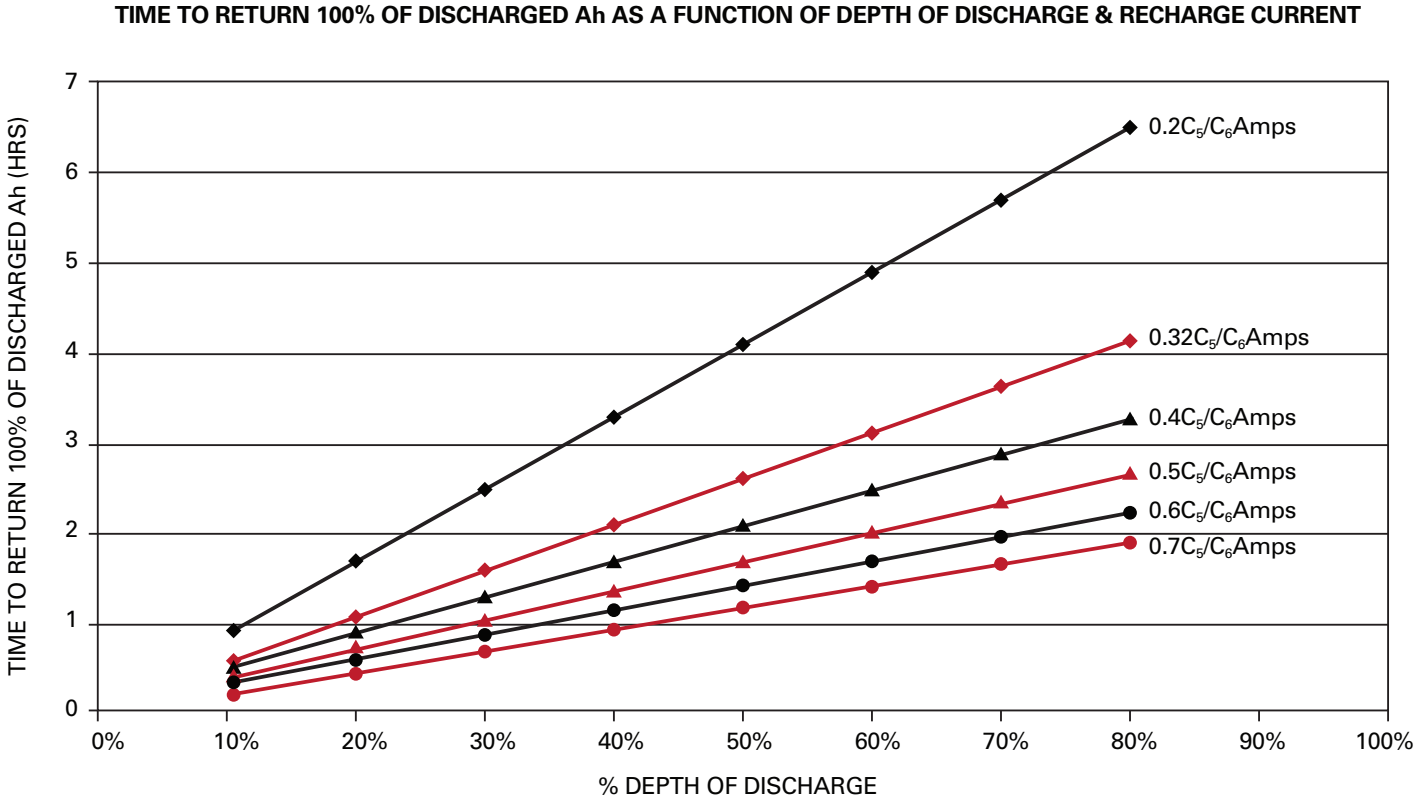
NexSys TPPL blocs must be charged with an EnerSys approved charger featuring the appropriate NexSys TPPL profile. *Figures 2 and 3* on the following page (p.12) show their exceptional fast charge characteristics at varying levels of DOD and inrush currents.

Figure 2 – Recharge Time - Return 80% of Discharged AHs



As an example, consider a 100Ah bloc discharged by 60Ah (to 60% DOD), leaving residual capacity of 40Ah. 48Ah will be returned after 0.8 hrs of charge with inrush current $0.6C_5$A.

Figure 3 – Recharge Time – Return 100% of Discharged AHs



NOTE: NexSys® TPPL blocs are designed to be charged with charging rates in range 0.25C_5/C_6 to 0.7$_5/C_6$ Charging at rates outside this range can affect the performance and life expectancy of the bloc. Contact EnerSys® before using rates outside this range.

The recharge process is not 100% efficient and the bloc will achieve approximately 97% state of charge following approved recharge procedures. A short absorption phase after recharging the 100% discharged AHs is required to ensure full bloc recovery. NexSys®+ chargers are programmed to achieve such recovery and deliver the recharge capabilities shown in *Figures 2 and 3*.

OPPORTUNITY CHARGING

NexSys TPPL blocs are suitable for partial state of charge operation, however the daily depth of discharge must not exceed 60% of the rated C_5/C_6 capacity and opportunity charging must be applied whenever the blocs are not being discharged (i.e., break / lunch times, shift handovers, etc.).

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

The electrochemistry of the NexSys TPPL battery series allows the bloc 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.

The SOC of the NexSys TPPL bloc 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 bloc receives a complete charge (returning the bloc to 100% of its rated C_5/C_6 capacity) at least once per week. Failure to do so will have a detrimental effect on the performance and cycle life of the bloc.

There are two approved charging profiles for the NexSys TPPL blocs:

a. Standard bloc profile which has charging rates of 0.25 – 0.70 C_5/C_6

b. NXPOB (On Board Application) profile which has charging rates of 0.2 – 0.4 C_5/C_6

Only these two profiles will enable NexSys TPPL blocs to achieve the cycle life quoted in this manual.

CYCLE LIFE

The life expectancy of the NexSys® TPPL bloc series depends on the application and its duty cycle.

While several factors affect the life of a bloc, cycle life depends primarily on the DOD.

Figure 4 – Cycle Life as a Function of Depth of Discharge 10%-80% (C_5/C_6 Rate)

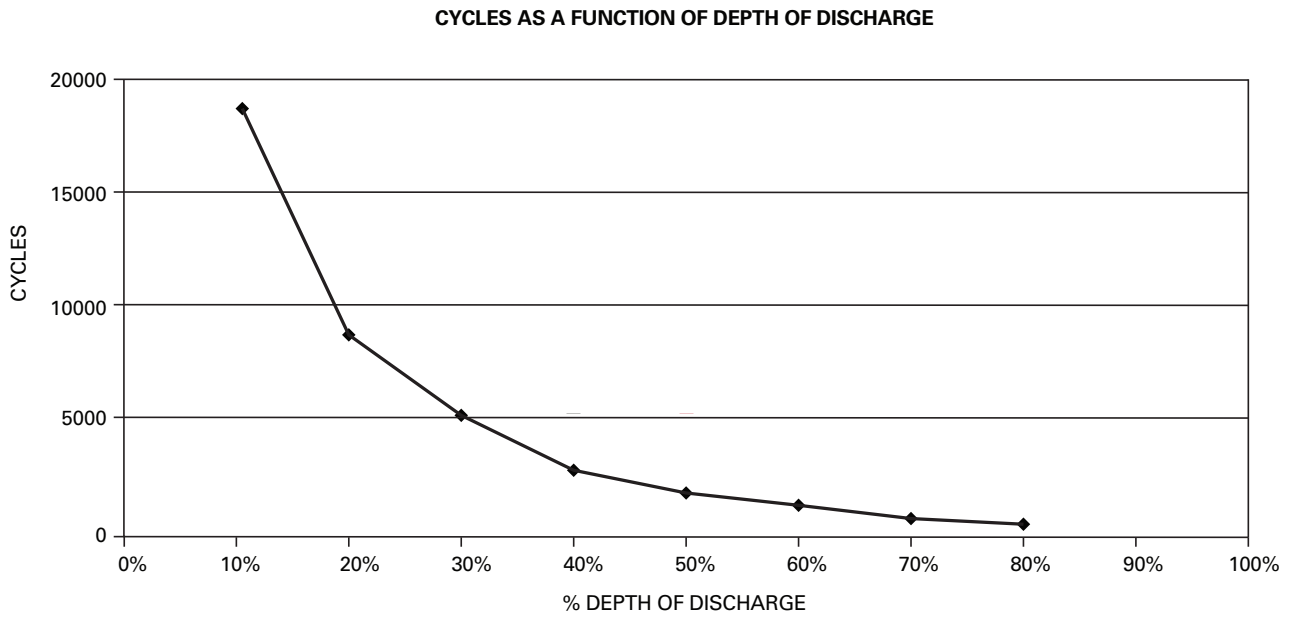


Table 8 – Illustrates This Relationship Between DOD and Cycle Life From Full State of Charge

Note: At 77°F

Cycles	
% DOD	NexSys® TPPL
10	19000
20	8500
30	5000
40	3000
50	2200
60	1500
70	900
80	700

DISPOSAL

NexSys® TPPL blocs are recyclable. Scrap blocs must be packaged and transported in accordance with prevailing transportation rules and regulations. Scrap blocs must be disposed of in compliance with local and national laws by a licensed or certified lead acid bloc recycler with these attributes.

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