The Yuasa little red *book* of *batteries*

YUASA

MILLENNIUM EDITION

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Yuasa has published this booklet to give the layman battery user an insight to lead Acid Batteries. Please accept it as a guide. It is not intended to replace in-depth technical publications that exist and are available on request.

Contents

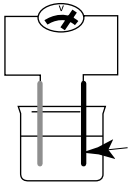
SECTION

What is a battery?

1

A battery is an electricity storage device which can be found in any number of shapes, sizes, voltages and capacities.

When two conducting materials (often dissimilar metals) are immersed in a solution, an electrical potential will exist between them If connected together through a closed circuit, a current will flow. The value of this potential (or voltage) is dependent on the materials used, giving rise to a whole family of battery types each having benefits and restrictions in use. Examples are:- lead acid, nickel cadmium (Nicad), lithium, silver alkaline.



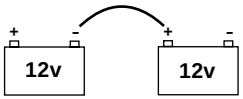
= 1 CELL

The plate with the more positive potential is denoted the positive plate

This manual is concerned only with one battery technology - the most successful - lead acid (lead and lead oxide immersed in sulphuric acid). Each cell has a 2 volt potential.

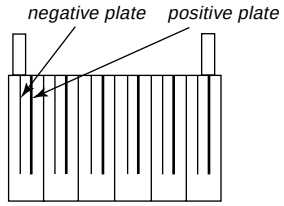
A battery is simply a number of cells connected together with a given voltage and capacity. The more cells the higher the voltage, the larger the plates the higher the capacity (in general).

Purely for convenience, batteries are made in 12 volt blocks with 6 cells but are also available in 6 volt, 4 volt and even 2 volt, single cell blocks.



= 24 VOLTS

Batteries can be connected in series to achieve whatever voltage is required (add the number of 2 volt cells) and in parallel to achieve the capacity required (add the capacities of each parallel battery or string of batteries) For larger systems, a number of series connected strings maybe connected in parallel witrh each other. This achieves both a higher voltage and capacity (see Section 3).



6 CELL = 12 VOLT LEAD-ACID BATTERY

The lead-acid battery

There are two concepts in lead-acid batteries

1. Sealed or Valve Regulated Lead Acid VRLA
2. Open - Vented

There are three basic applications

1. Industrial
2. Automotive (starter i.e. Cars, commercial vehicles)
3. Traction (Electric motor drive i.e. milkfloat)

WARNING - DO NOT USE THE WRONG BATTERY FOR THE APPLICATION.

This guide is focused on Industrial Standby applications and NOT Automotive or Traction use.

Industrial batteries

Industrial batteries are available from two distinct groups with the following features. Note: VRLA have superseded open-vented in many applications

OPEN-VENTED	VRLA/SEALED
• Older technology	• Environmentally friendly
• Require separate battery room	• Use directly in office environment
• Regular routine maintenance	• Low maintenance - “Maintenance free”
• Separate safety requirements	• Self-contained. Safe
• Store/use in vertical position	• Store/use in any orientation
• Can require extensive cabling	• Can be used internal or adjacent to load

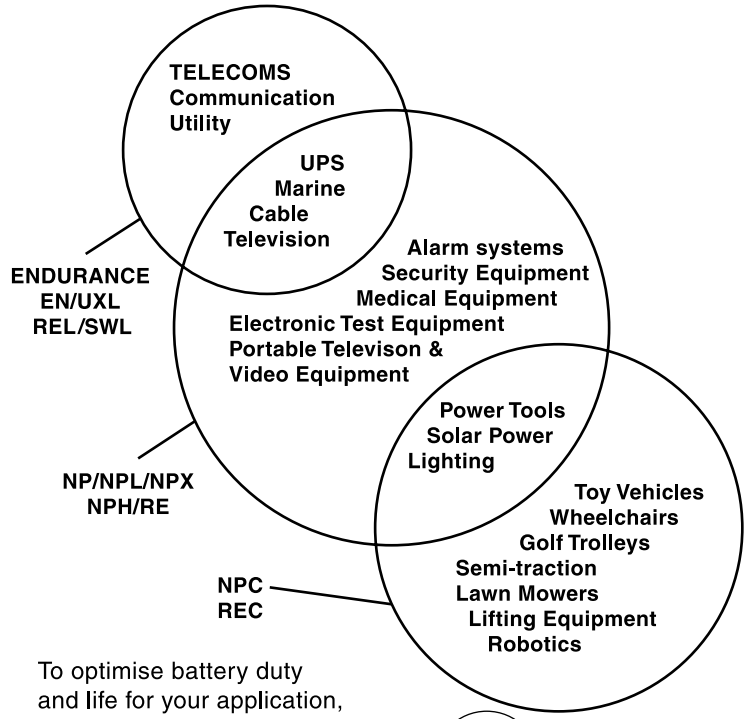
• VRLA has in many instances replaced the open-vented type.

Note: The term sealed lead-acid SLA is an old acronym considered misleading and is now replaced by Valve Regulated Lead Acid VRLA.

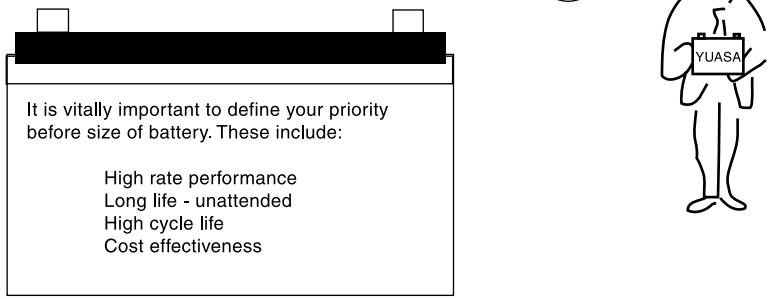
Typical Applications

2

The Yuasa range focuses on VRLA technology.



To optimise battery duty and life for your application, make sure you choose the right product from the Yuasa range.



Choosing the correct size of battery

3

As mentioned earlier, batteries come in all shapes and sizes, from types no larger than a shirt button, to a battery system filling an entire room.

To find the size of battery you require you generally need two pieces of information, battery load and back-up times. (Note: other factors may also have an effect).

Battery Load

Whether you power lights, motors, electronic equipment or a toy vehicle your equipment will draw a load in AMPS. If this is unknown then the equipment will have a rating expressed in Watts which may simply be converted to Amps by dividing the value by the normal voltage of the system.

Example, You have chosen NPC for high cycle life and wish to drive a power tool rated at 120 watts 12 volts.

Load current = 120 ÷ 12 - 10 Amps

Back-up time

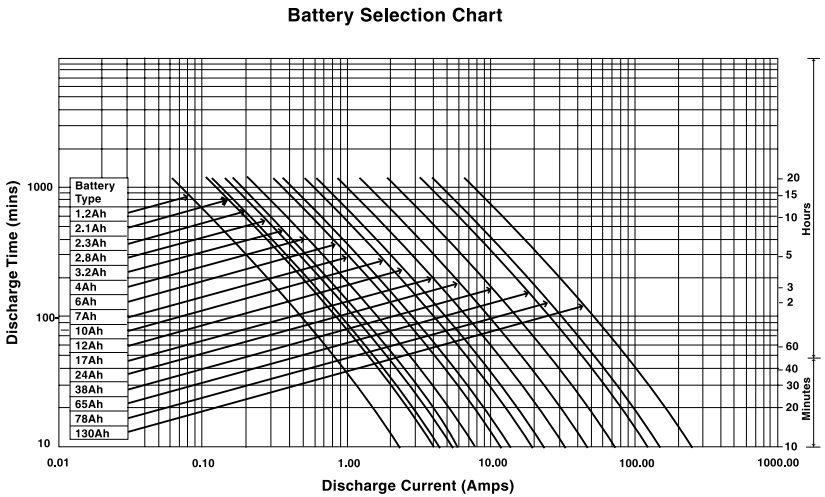
This is the time you require the battery to support the load described above and is often called Autonomy or discharge time.

Example: To power a cordless electric tool for a total of 3.0 hours before recharging.

With these two pieces of information use our selection graph to plot an intersection point from which you will determine a required size or capacity in Amp. hours (Ah).

Our figure No.1 has been rationalised into rounded figures of capacity. If your intersection point falls between two lines choose the next highest value.

Figure 1. NP Types



Always choose a suitable sized battery from the ranges appropriate to your application.

You may notice that the chosen capacity in Amp hours is often higher than the Value of Amps x Hours used, in our example using 10 AMPS x 3 HRS = 30Ah and the chosen option being 38Ah. This is because the capacity 'cA' of each NP battery is stated at the 20 hour discharge rate. You will only get full capacity if discharged over that length of time.

Note:- This explanation is a simplified version, if in any doubt call our Technical department on 01793-645753.

Simplified Selection Matrix

Legend A = Excellent B = good C = Fair

	NP	NPL/RE	NPC REC	NPH/NPX SW/SWL	EN/ UXL REL
Float Life upto 5 years	B	A	-	B	A
Cyclic Life	C	C	A	B	B
Float Life upto 10 years	-	B	-	-	A
High Rate Discharge	B	B	-	A	B
Float Charge Applications	A	A	B	A	A
Energy Density C20/C10	B	B	B	B	B
Specific Energy C20/C10	B	C	B	B	B
Specific Energy C1/0.5	B	B	B	A	B
Portable Applications	C	B	A	B	-

Charging

4

Correct charging of a VRLA battery is essential in optimising battery performance and life. Although a constant voltage charge should be applied, optimum charging also depends on temperature (Nominally 20°C), charge current (max 1/4 battery capacity) and ripple current (minimum). Two basic categories of charging exist.

Float/Standby

This charging method is used in applications such as emergency back-up when the battery is required only upon mains failure e.g., Alarm Panels, Emergency Lighting, UPS. In each case the battery is continuously on charge and consequently the recommended voltages are slightly lower than cyclic charging so as not to damage the battery. (Float voltage for Yuasa NP range = 2.275 volts/cell).
These figures may vary between different battery types.

Cyclic

Cyclic charging is used in applications where the battery is repeatedly discharged then charged, e.g. Portable equipment, Wheel Chairs, Golf trolleys etc.

A higher charging voltage is used but should NEVER be left on indefinitely since it will overcharge and destroy the battery. (Cyclic voltage for Yuasa NP range = 2.4 - 2.5 volts/cell)

For optimum performance always recharge a battery immediately after discharging.

Note - Consult the individual battery specification for the correct charging voltage or contact Yuasa Technical Department on 01793-645753

Battery Storage, Care & Maintenance

5

The Storage or shelf life of a VRLA battery is usually between 12 and 18 months at 20°C starting from a charged condition.

Warning - Never store in a discharged or partially discharged state.

Always store in a dry, clean, cool environment in a fully packaged condition.

If storage of 12 months or longer is required supplementary charging will be required.

Design Life

Float Each battery type will have a prescribed float design life. Please be aware of this life expectancy and replace the battery as End-of-Life approaches. Keep a reference or label the battery to show its date of installation to facilitate replacement at the correct time. Factors other than time may affect the life of the battery and this will be indicated by a reduction in capacity. The battery should be changed when the capacity is reduced to a level that will prevent it fulfilling its required duty. This may be well in advance of its design life if, for example, the ambient temperature is considerably above 20°C ie 30°C or more.

Cyclic Each battery suited to cyclic use will reach End-of-Life after a prescribed number of cycles. This number is dependant upon the depth of discharge of each cycle. The deeper the discharge, the less number of cycles to End-of-Life. Depth of discharge is expressed as the percentage of the battery capacity required per duty cycle.

Battery Care

Each Yuasa VRLA battery is supplied in a charged condition having passed stringent quality checks.

To ensure optimum battery performance and life, it helps to take care of your battery by observing the following:-

Sulphation/Undercharge

WARNING - Never leave a VRLA Battery in a discharged state.

If a battery has an open-circuit voltage lower than its rated value, then sulphation may well be the cause.

When a battery is left in a discharged state or for prolonged periods of storage, lead sulphate crystals begin to form acting as a barrier to recharge and will prevent normal battery operation.

Depending on the degree of sulphation, a battery may be recovered from this condition by constant current charging at a higher voltage with the current limited to one tenth of the battery capacity for a maximum of 12 hours.

Note: The applied voltage will exceed the normal recommendation and so the battery must be monitored (not left unattended) and removed from charge if excess heat is dissipated. The voltage required to “force” this maximum current into the battery will reduce as the battery recovers until normal charging can take place.

In extreme circumstances a battery may never fully recover from sulphation and must therefore be replaced.

If in doubt call Yuasa Technical Dept 01793-645753

Overcharge

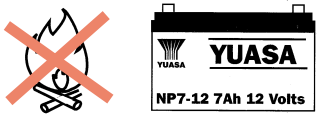
As mentioned in Section 4 optimum charging relies mainly on voltage, current and temperature factors which are interrelated and all of which can cause overcharge.

Excessive charge voltages will force a high overcharge current into the battery, which will dissipate as heat, and may cause gas emission through the safety valve. Within a short period of time this will corrode the positive plate material and accelerate the battery towards end-of-life.

Under these conditions the heat produced inside the battery can lead to thermal runaway due to the increased electrochemical reaction within the battery. The battery may swell before failing and will be irrecoverable from this state. This situation is potentially dangerous

Temperature

Warning - Heat Kills Batteries.



The recommended normal operating temperature is 20°C.

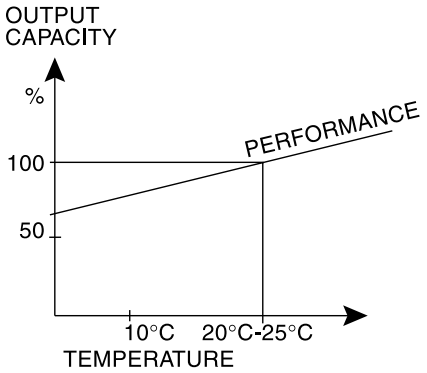
HIGH TEMPERATURE will reduce battery service life often quite dramatically (see figures 2 and 3). In extreme cases this can cause Thermal Runaway, resulting in high oxygen/hydrogen gas production and battery swelling. Batteries are irrecoverable from this condition and should be replaced.

Temperature (°C)	20°	25°	30°	35°	40°	45°	50°
% Expected Float Life	100%	71%	50%	35%	25%	18%	13%

Figure 2

Figure 3

Notice that high temperatures will give increased performance but with a corresponding loss in life



LOW TEMPERATURES will help to ensure a long service life but batteries used at low temperatures have reduced capacity.

For detailed information contact Yuasa Technical Dept 01793-645753.

Battery Safety

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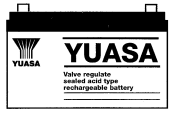
danger

Batteries are electrically live at all times, take great care NEVER to short-circuit the battery terminals.



danger

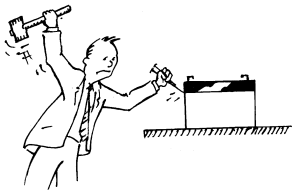
High D.C. voltages, are more dangerous than the mains.

warning

Batteries are heavy, take care when lifting and transporting batteries. For weights above 24 kilos, lifting aids should be used.

warning

Do not attempt to remove battery lid or tamper with the battery internal workings. VRLA Batteries are “low-maintenance” requiring no electrolyte top-up or measurement of Specific Gravity.



Disposal/Re-Cycling

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Finally, when a battery has reached the end-of-life it must be returned to the point of sale or to a licensed battery dealer for recycling. Please observe the following points.

caution

Do not throw batteries in a bin at end-of-life. VRLA batteries contain substances harmful to the environment so return to your supplier or take to your Council tip for disposal.

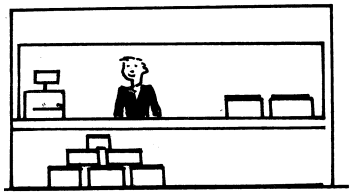
Pb

caution

Never bury in the ground or incinerate at end-of-life. Batteries contain harmful substances making this unsafe.

always

Return the spent battery to your Stockists, the Local Council tip or any licensed battery dealer for re-cycling.



Jargon Made Easy

Abbreviations

VRLA - Valve regulated lead acid battery.
SLA - Sealed Lead-acid
CCV - Closed - circuit voltage.
OCV - Open - circuit voltage.
WPC - Watts per cell.
Pb - Chemical symbol for lead.
UPS - Uninterruptible power supply.
Ah - Amp hour. The unit of battery capacity
DOM - Date of manufacture.
EOD - End of discharge.
VPC - Volts per cell.
Nc - Number of cells.
V_f - Float Voltage.
Vs - Starting Voltage.
I_{AV} - Average current.
Sg - Specific gravity
cAn - Is the defined capacity of the battery to the 'n' time period.
20hr Rate - The capacity a battery will deliver over 20hrs

Definitions

Battery - one or more cells.

Float/Standby - Continuous charging for use in an emergency or back-up application.

Cyclic - Continual discharge/recharge application often associated with traction applications.

Battery String or Bank - A number of batteries connected in series will constitute one string. Strings can then be connected in parallel to achieve the required capacity.

Monobloc - A phrase used to describe a multi - celled single block.

Wet/Flooded - Open-vented lead-acid cells which need topping up, i.e. not maintenance free.

Stationary - Applications using static placed batteries.

Top - charging - A service charge during or after storage, usually at a level slightly higher than normal float V.

Did You Know?

In addition to one of the widest range of Valve Regulated Lead Acid batteries available in the world – Yuasa also offer Lithium Primary Cells, Nickel Cadmium and Nickel Metal Hydride rechargeable batteries. Full technical information on our current available stock can be supplied on request.

Nickel Cadmium/Nickel Metal Hydride

Yuasa NiCad and NiMH product utilises all the latest advances in battery technology. Due to the ever changing nature of these products, please check with us for availability and latest specifications. We offer most standard battery sizes and capacities in many different pack configurations with options on leads, plugs and solder tags. Many packs are made for the Emergency lighting market.
E.g. part No 3DH4T4. This part reference means 3 x D cells of 4000mAH High Temp with solder Tags in a Stick configuration (Style 4)

Yuasa "Prismatic" Nickel - Cadmium batteries

These batteries offer what is believed to be one of the highest energy profiles available in Nickel Cadmium compared to similar sized batteries.

Yuasa has applied over 80 years of experience of lead acid battery technology in the production of VRLA type batteries with a choice of over 60 different models from 8 different ranges.

Standard NP
Available in a wide range of sizes to suit general applications.

NPH/NPX/SW and SWL
High performance batteries specially designed for applications requiring high rate discharge supplying up to 50% more power (watts) for short durations when compared to conventional NP models.

NPL/RE
The extended service life version of the NP designed for normal standby and float service applications. NPL's now available to BS6290 pt4.

NPC/REC
Specifically designed to suit the arduous requirements of cyclic applications allowing increased cycle life (at least double that of conventional types).

Endurance
The premium long life battery from Yuasa that fully complies with BS6290pt4 and IEC896pt2.

REL RELIART
Extra long life batteries. 15 year design life.

UXF
This specially designed range of Front terminal batteries is ideal for high power density applications, including Telecoms and UPS.

We have Quality Assurance Standard BS5750 ISO 9000 Part 2 for our UK battery manufacturing plant. Our customers can be assured that when they choose Yuasa they are choosing a state-of-the-art power source manufactured to the highest attainable quality standard.

For further information on our products your local distributor or stockist is fully qualified to help you.

You are of course welcome to make contact direct with any of our Sales & Marketing Companies in the UK, Germany, France and Italy.

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