VTX 3.3
June 2013


# Vantex New Generation

## Ni-Cd battery

## Technical manual

For cells delivered before May 2012, use the Technical manual VTX3.1 – September 2010

**Delivering quality**

ALCAD

# Contents

# 1. Introduction

The nickel-cadmium battery is the most reliable battery system available in the market today. Its unique features enable it to be used in applications and environments untenable for other widely available battery systems. To offer a highly reliable battery of zero or ultra-low maintenance Alcad has developed the Vantex New Generation maintenance-free pocket plate battery. The term “maintenance-free” in this publication means that no addition of water is necessary during the lifetime of the product when operated under Alcad’s recommended conditions.

This publication details the design and operating characteristics of the Alcad Vantex battery. When operated in recommended conditions, Vantex New Generation will not require any topping-up during its entire service life. Other regular maintenance checks are still necessary (see section 10 Installation and operating instructions). In addition to all the well-proven advantages of the nickel-cadmium pocket plate battery, Vantex offers exceptional electrical performance enabling customers to benefit from a smaller battery capacity to suit their specific applications. Alcad Vantex is certified compliant to IEC 60623 / IEC 62259 battery standards.

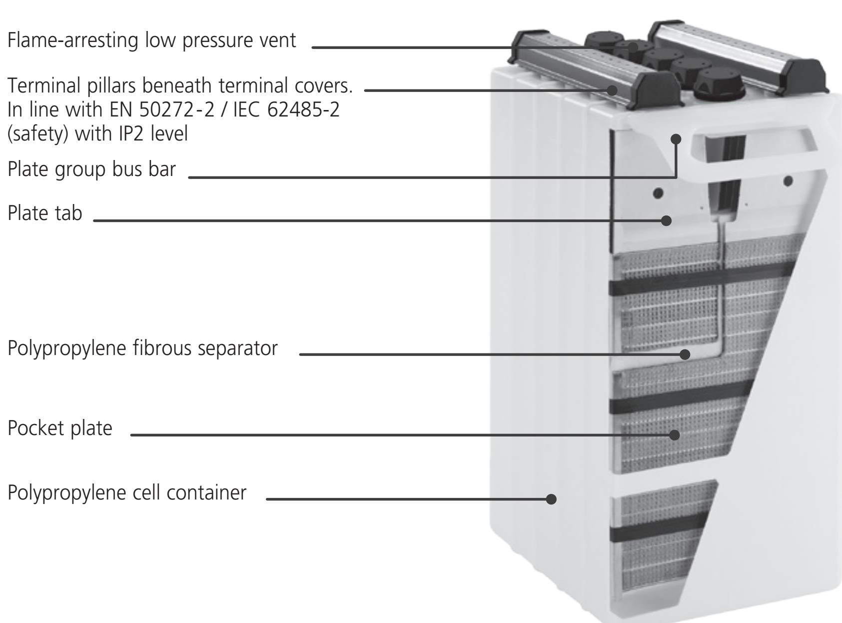
# 2. Applications

- UPS
- Process control
- Emergency systems
- Security systems
- Offshore oil and gas
- Switchgear

Vantex batteries are designed to supply the ideal maintenance-free power backup solution for installations that demand maximum reliability and optimum TCO (Total Cost of Ownership) while operating for long periods at high ambient temperatures. Vantex is especially suited for the oil and gas, utility and electricity industries where availability and reliability of backup power is essential.

# 3. Construction features

**Vantex New Generation battery**




Cells are welded together to form rugged blocks up to 10 depending on cell size and type.

Construction of the Alcad Vantex cell is based upon Alcad pocket plate technology and a new high-tech concept designed to achieve maintenance-free operation in terms of topping-up, improved performance and chargeability.

### 3.1 Plate assembly

The nickel-cadmium cell consists of two groups of plates, one containing nickel hydroxide (the positive plate) and the other containing cadmium hydroxide (the negative plate).

The active materials of the Alcad Vantex pocket plate are retained in pockets formed from nickel-plated steel strips double-perforated by a patented process. These pockets are mechanically linked together, cut to the size corresponding to the plate width and compressed to the final plate dimension. This process leads to a component which is not only mechanically robust but also retains its active material within a steel boundary which promotes conductivity and minimizes electrode swelling.

These plates are then welded to a current carrying bus bar which further ensures the mechanical and electrical stability of the product.

The alkaline electrolyte does not react with steel, which means that the supporting structure of the Vantex battery stays intact and unchanged for the life of the battery. There is no corrosion and no risk of "sudden death".

### 3.2 Separator

The separator is a key feature of the Vantex battery. It is a polypropylene fibrous material which has been used and proven by Alcad in the Vantage ultra-low maintenance product over more than 20 years and has been further optimized for this product to give the features required.

Using this separator, the distance between the plates is carefully controlled to give the necessary gas retention to provide the level of recombination required.
By providing a large spacing between the positive and negative plates and a generous quantity of electrolyte between plates, the possibility of thermal runaway is eliminated.

### 3.3 Electrolyte

The electrolyte used in Vantex, which is a solution of potassium hydroxide and lithium hydroxide, is optimized to give the best combination of performance, life and energy efficiency over a wide operational temperature range.

With the Vantex, as with all nickel cadmium, the electrolyte concentration does not change significantly between a full charged state and a full discharged state. It retains its ability to transfer ions between the cell plates irrespective of the charge level. In most applications the electrolyte will retain its effectiveness for the life of the battery and will never need replacing.

There are two types.
a) The standard type concentration is such as to allow the cell to be operated to temperature extremes as low as - 20°C (- 4°F) and as high as + 70°C (+ 158°F). This allows the very high temperature fluctuations found in certain remote regions to be accommodated.
b) For continuous temperatures below - 20°C (- 4°F) an arctic electrolyte is used. It is a special high density electrolyte.

### 3.4 Terminal pillars

Short terminal pillars are welded to the plate bus bars using a well-proven battery construction method. They are constructed of nickel-plated steel and are internally threaded.

The pillar to lid seal uses a compressed visco-elastic sealing method. The pillars are held in place by compression lock washers. This assembly is designed to provide satisfactory sealing throughout the life of the product.

### 3.5 Venting system

Vantex is fitted with a flame-arresting low-pressure vent for each cell of the battery. This vent operates as a one way valve (as defined in IEC 60050-482) which will allow the release of small quantities of hydrogen and non-recombined oxygen. It allows venting if the internal pressure exceeds a fixed safety value. The self-closing vent has an integral porous disk, for flame-arresting function, to prevent an external ignition from spreading into the Vantex cell.

### 3.6 Cell container

The Vantex is built up using the well-proven Alcad block battery construction. The tough polypropylene containers are welded together by a heat sealing technique. The assembly of the blocks is completed by a clip-on terminal cover which gives protection to IP2X according to IEC 60529 standard for the conductive parts.

# 4. Principles of the oxygen recombination cycle

In a conventional flooded electrolyte pocket plate nickel-cadmium battery water is lost from the battery on overcharge due to the following reactions:

**At the positive plate**
$4OH^- \longrightarrow 2H_2O + O_2 + 4e^-$
(Oxygen evolution)

**At the negative plate**
$4H_2O + 4e^- \longrightarrow 2H_2 + 4OH^-$
(Hydrogen evolution)

This corresponds to a theoretical loss of 36 g of water for 107 Ah of overcharge i.e. 0.335 $cm^3$ per Ah. Hence a conventional cell requires periodic addition of water. The frequency of this operation depends upon the cumulative amount of charge received and the operating temperature.

During the charging process evolution of oxygen begins to occur a little before the positive plate reaches its fully charged state and then becomes the main reaction when the fully charged condition is reached. However, the cadmium negative plate has a better charge acceptance than the positive plate and hydrogen is not evolved until this plate is virtually fully charged.

The oxygen which is produced at the positive plate surface is collected by the special porous separator and thus not allowed to escape from the region between the plates. Some displacement of electrolyte within the separator occurs, thus generating extra unfilled pores for the diffusion of oxygen directly to the adjacent cadmium negative plate.

As soon as the oxygen reaches the negative plate it reacts either chemically or electrochemically. In both cases, the oxygen recombination prevents the negative plate from fully charging and in turn it suppresses the evolution of hydrogen gas. In the Vantex design, the separator and plate stack are optimized to minimize hydrogen evolution and water usage when operated as recommended. This ensures a long service life without the need to replenish with water. The Vantex recombination is exceeding the IEC 62259 minimum requirement level of 70 % and achieves more than 95 %.

The Vantex battery is fitted with a low pressure vent on each cell. On overcharge the cells have an internal pressure above atmospheric pressure. The vent acting as a valve provides an outlet for the release of small quantities of hydrogen and non-recombined oxygen and thus controls the internal pressure. When the pressure falls below the release pressure either on open circuit or on discharge the vent reseals to prevent ingress of air and to minimise self-discharge reactions.

# 5. Battery features

### Complete reliability
Does not suffer from the sudden death failure due to internal corrosion associated with other battery technologies.

### Long cycle life
The Vantex battery has a long cycle life even when the charge/discharge cycle involves 100 % depth of discharge (see section 6.7 Cycling).

### Exceptionally long floating lifetime
A lifetime in excess of twenty years is achieved by Vantex in many applications, and at elevated temperatures it has a superior life when compared to other available battery technologies.

### Maintenance-free
With its special recombination separator combined with its low pressure vent and generous electrolyte reserve, Vantex eliminates the need for topping-up with water under recommended operating instructions – from - 20°C (- 4°F) to + 40°C (+ 104°F) at 1.42 V/cell with temperature compensation (see section 7.2 Temperature compensation).
Note that it is possible to add water if required.

### Simple installation
Vantex can be used with a wide range of stationary and mobile applications as it produces no corrosive vapors, uses corrosion-free polypropylene containers and has a simple bolted connector assembly system (see section 10 Installation and operating instructions).

### Wide operating temperature range
Vantex employs an electrolyte which allows a normal operating temperature of from - 20°C to + 40°C (- 4°F to + 104°F) and accepts extreme temperatures, ranging from as low as - 40°C with arctic electrolyte to + 70°C (- 40°F to + 158°F) (see section 3.3 Electrolyte).

### Fast recharge/improved chargeability
Vantex can be recharged at high currents which allow very fast recharge times to be achieved (see section 7.4 Charge efficiency).

### Resistance to mechanical abuse
Vantex is designed with a high mechanical strength. It withstands all the harsh treatment associated with transportation over difficult terrain (see section 8.2 Mechanical abuse).

### High resistance to electrical abuse
Vantex will survive abuse which would destroy other battery technologies. For example, it can withstand overcharging, deep discharging, and high ripple currents without damage (see section 8.1 Electrical abuse).

### Well-proven pocket plate construction
Alcad has nearly 100 years of manufacturing and application experience with respect to the nickel-cadmium pocket plate product. This expertise has been built into the twenty-plus years' design life of the Vantex product (see section 3 Construction features of the Vantex New Generation battery).

### Extended storage
When stored in the filled and charged state in normal condition (0°C to + 30°C / + 32°F to + 86°F), Vantex can be stored for up to 2 years (see section 10 Installation and operating instructions).

### Environmentally safe
Alcad operates a dedicated recycling center to recover the nickel, cadmium, steel and plastic used in the battery (see section 12 Disposal and recycling).

### Low life-cycle cost
When all the factors of lifetime, low maintenance requirements, simple installation and storage and resistance to abuse are taken into account, Vantex becomes the most cost effective solution for many professional applications.

# 6. Operating characteristics

## 6.1 Capacity

The Vantex battery capacity is rated in ampere-hours (Ah). Its rated Ah is the quantity of electricity at + 20°C (+ 68°F) which it can supply for a 5 hours runtime to 1.0 V/cell after being fully charged. This is in accordance with both IEC 62259 and IEC 60623 standard.

In accordance with these IEC standards, the current can be expressed as a function of this 5 hours capacity or the $C_5$ capacity. For example, the expression 0.2 $C_5$ A is equal to 20 % of the $C_5$ capacity in Amps. The expression follows the IEC specification since the declared nominal capacity ($C_n$) is the runtime of 5 hours. So in that case, 100 % of the Ah is delivered in 5 hours of runtime at $C_5$/5 A or 0.2 $C_5$ A. When the discharge current deviates from 0.2 $C_5$ A so will the delivered capacity or runtime.

In practice, Vantex is used in floating conditions and so the tabular data is based upon cell performance after several months of floating. This eliminates certain correction factors which need to be used when sizing batteries with conventional fully charged open cell data (see section 9 Battery sizing principles).

## 6.2 Cell voltage

The cell voltage of nickel-cadmium cells results from the electrochemical potentials of the nickel and the cadmium active materials in the presence of the potassium hydroxide electrolyte. The nominal cell voltage is 1.2 V.

## 6.3 Internal resistance

The internal resistance of a cell varies with the temperature and the state of charge.

In the fully charged state and at high temperature, the internal resistance is the lowest. The internal resistance is characterized by measuring the response in discharge voltage with a change in discharge current.

The internal resistance of a Vantex cell has the values given in the product literature for fully charged cells at normal temperature.

For lower states of charge the values increase. At 50 % discharged, the internal resistance is about 20 % higher, and at 90 % discharged, it is about 80 % higher. When the temperature decreases below 20°C, the internal resistance increases. At 0°C (+ 32°F), the internal resistance is about 40 % higher.

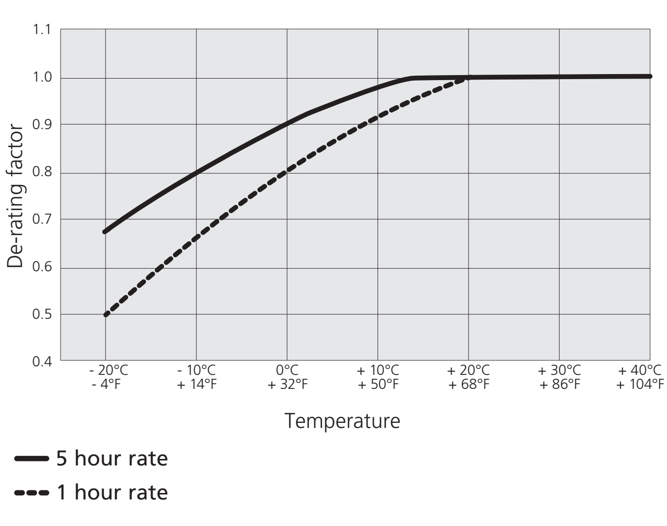
## 6.4 Effect of temperature on performance

Variations in ambient temperature affect the performance of Vantex and this needs to be taken into account when sizing the battery.

Low temperature operation reduces the discharge performance but at the high temperature, the discharge performance is similar to those at normal temperatures.

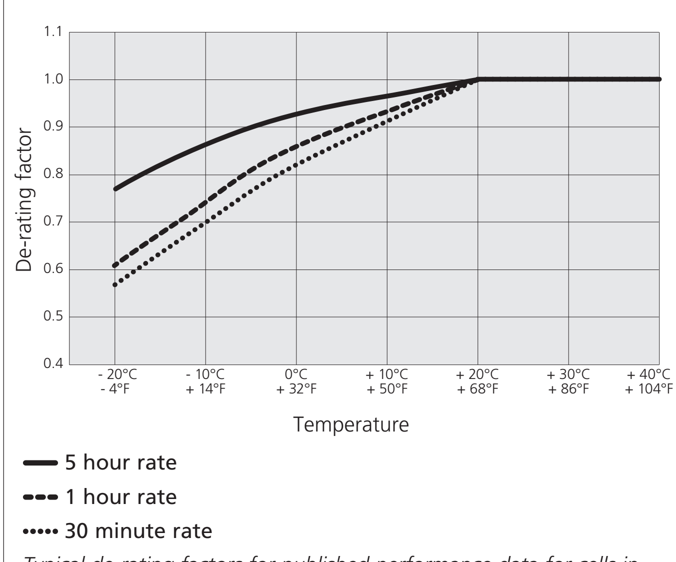
Temperature de-rating factors for L and M type cells are given in Figure 1(a) and Figure 1(b) for operating temperature - 20°C to + 40°C (- 4°F to + 104°F).

**Figure 1(a): Temperature de-rating factors for L type cell for cell final voltage 1.00 V**




*Typical de-rating factors for published performance data for cells in floating applications*

**Figure 1(b): Typical de-rating factors for M type cell for cell final voltage 1.00 V**




*Typical de-rating factors for published performance data for cells in floating applications*

## 6.5 Short-circuit values

The typical short-circuit value of a Vantex cell is given in Table 1. The Vantex battery is designed to withstand a short-circuit current of this magnitude for many minutes without damage.

**Table1: Short-circuit currents at + 20°C (+ 68°F) for fully charged cells**

| Type | Amperes |
|---|---|
| L | 6 * $C_5$ A |
| M | 11* $C_5$ A |

## 6.6 Open circuit loss

The state of charge of Vantex on open circuit slowly decreases with time due to self-discharge. In practice this decrease is relatively rapid during the first two weeks but then stabilizes to about 2 % per month at + 20°C (+ 68°F).

The self-discharge is affected by the temperature. At low temperatures the self-discharge decreases and so the open circuit loss is reduced. At high temperature the self-discharge is increased and the open circuit loss is also increased.

The open circuit loss for Vantex is shown in Figure 2 for a one year period.

## 6.7 Cycling

Vantex is a maintenance-free product when used under recommended conditions in stationary and not continuous cycling applications. Nevertheless, it is designed using conventional pocket plate electrode technology and has therefore an equivalent cycling capability.

If Vantex is used in a continuous cycling application, the water consumption may be significantly increased. In that case, watering the cells during their useful life will be necessary. However, there are cycling applications where Vantex can be beneficial. This will depend on the frequency and depth of discharge involved. For example, in a poor power quality stationary application, the Vantex battery can provide superior cycling duty with infrequent or no watering intervals (see section 8).

## 6.8 Water consumption

The Vantex battery works on the oxygen recombination principle and therefore has a reduced water consumption. The Vantex recombines at least at a level of 95 % when float charging (as per IEC 62259 methodology). It has a water usage reduced by a factor of up to 10 times of that of an open flooded cell. When operated as recommended, the Vantex will not need topping-up during its entire service life.

## 6.9 Gas evolution

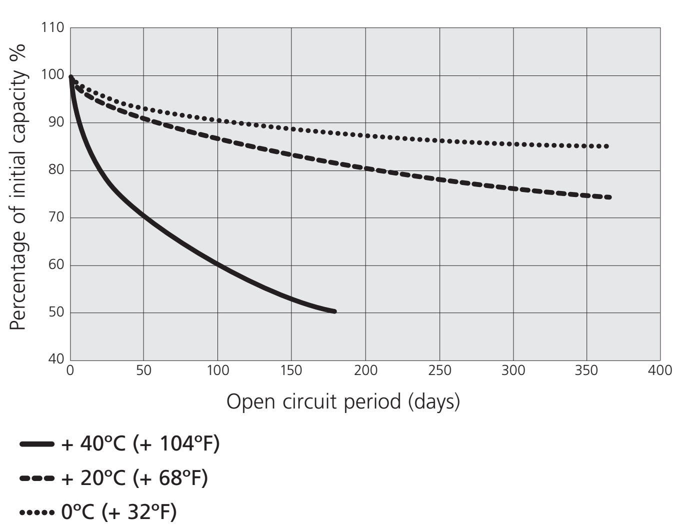
Gas is generated during overcharge through electrolysis when gas doesn't recombine, it will eventually exhaust from the cell. The electrolysis of 1 $cm^3$ of water produces about 1865 $cm^3$ of gas mixture and this gas mixture is in the proportion of 2/3 hydrogen and 1/3 oxygen. Thus the electrolysis of 1 $cm^3$ of water produces about 1243 $cm^3$ of hydrogen.

Table 2 gives the values for $I_{gas}$ used to estimate ventilation needs in accordance with IEC 62485-2 / EN 50272-2.

**Table 2: Values for current $I_{gas}$ producing gas when charging at constant current or potential**

| | $I_{gas}$ (mA/Ah) |
|---|---|
| Under float charge conditions 1.42 V/cell | 2 |
| Under boost charge conditions 1.45 V/cell | 5 |
| Under all commissioning charge conditions<br>Constant current charge and constant potential charge | 100 |

**Figure 2: Typical open circuit loss variation with time**



# 7. Battery charging

In order to ensure that the maintenance-free properties of the Vantex battery are achieved, it is necessary to control the charge input to the battery to optimize the rate of water loss during the life of the product.

The Vantex battery must be properly commissioned (see section 10) before putting in service and applying the following charging methods.

It is important therefore that the recommended charge conditions are complied with.

## 7.1 In service – charging methods

The single level float charging method is adequate to maintain the Vantex in a good state of operation over its useful life. It should not be required to implement a two level constant potential charging method if Vantex is used in a stationary power application and the installation, commissioning and operation is done in accordance with Alcad Installation and Operating instructions (see section 10). Vantex batteries may be charged quickly and simply by the following methods:

**a) Two level constant potential charging**

The initial stage of two-rate constant potential charging consists of a first charging stage to a maximum voltage of 1.45 ± 0.01 V/cell. Up to 12 hours of recharge time with this initial stage of charge is necessary when fully discharged. After this first stage the charger should be switched to a second maintenance stage at a float voltage of 1.42 ± 0.01 V/cell. After a prolonged mains failure the first stage should be reapplied manually or automatically.

**b) Single level float charging**

Vantex batteries are float charged at 1.42 ± 0.01 V/cell from a fully discharged condition to a high state of charge. This is detailed in section 7.2. Temperature compensation is required to avoid the need for water topping over its useful life.

## 7.2 Temperature compensation

At + 20°C (+ 68°F) and at a fixed voltage of 1.42 VPC, Vantex operates with an optimized balance between stabilized state of charge (SOC) and water consumption. Vantex gives, in this case, the highest performance and no watering maintenance benefits over its useful life. In order to maintain this optimized condition in standby operation, Temperature Compensated Voltage (TCV) control is recommended.

When the temperature increases above + 20°C (+ 68°F) at a fixed voltage, the float current increases, the charge efficiency decreases and the water consumption increases. As a result, to maintain an optimized balance between state of charge (SOC) and water consumption, the voltage should decrease.

When the temperature decreases below + 20°C (+ 68°F), at a fixed voltage, the reverse occurs, i.e. the float current decreases, the charge efficiency increases and the water consumption decreases. As a result, to maintain an optimized balance between state of charge (SOC) and water consumption the voltage should increase.

When the temperature increases, then the electrochemical behaviour becomes more active and so, for the same charge voltage, the current at the end of charge increases. This increases the water usage. For this reason it is recommended to operate with Temperature Compensated Voltage (TCV) control active. Water consumption, when operating at high temperatures, is reduced allowing the Vantex to operate without the need of watering maintenance over its useful life.

When operating at low temperatures, the reverse occurs. For that reason it is recommended to operate with Temperature Compensated Voltage (TCV) control in order to increase the charge acceptance. This control contributes to maintaining a high state of charge and in turn an acceptable level of discharge performance.

Table 3 gives the TCV control slopes according to the temperature in dual and single control method. In dual control, the TCV control slopes are different below and above + 20°C (+ 68°F). If only one TCV control can be implemented then use the slope that corresponds best with the temperature range expected in the application. In single control, the TCV slope is the same below and above + 20°C (+ 68°F). If no TCV control is available, operate with a fixed voltage setpoint of 1.42 V/cell.

**Table 3: Temperature Compensated Voltage (TCV) control as a function of temperature for dual and single method**

| Control method | | Dual | | Single |
|---|---|---|---|---|
| VPC (Volt Per Cell) | | < + 20°C (+ 68 °F) | > + 20°C (+ 68 °F) | |
| T (°C) | T (°F) | -3.0 mV / °C / Cell (-1.68 mV / °F / Cell) | -2.0 mV / °C / Cell (-1.12 mV / °F / Cell) | -2.5 mV / °C / Cell (-1.4 mV / °F / Cell) |
| -20 | -4 | 1.540 | | 1.520 |
| -10 | 14 | 1.510 | | 1.495 |
| 0 | 32 | 1.480 | | 1.470 |
| **20** | **68** | **1.420** | **1.420** | **1.420** |
| 30 | 86 | | 1.400 | 1.395 |
| 40 | 104 | | 1.380 | 1.370 |
| 50 | 122 | | 1.360 | 1.345 |

### 7.3 Charge acceptance

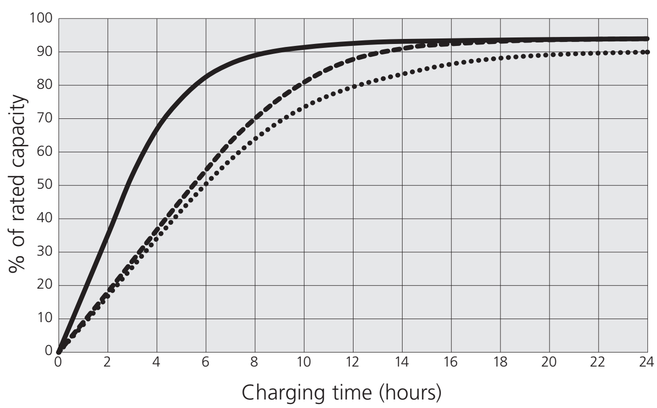
The performance data sheets for Vantex are based upon several months' floating and so are for fully float charged cells. A discharged cell will take a certain time to achieve the state of charge. Figure 3 gives the available capacity during charge. For stationary application, the recommended charge voltage is 1.42 ± 0.01 V for floating and 1.45 ± 0.01 V for the first stage of a two step charge. Up to $0.2C_5$ A of recharge current can be used. After 2 hours charge continues whereby a full state of charge will be reached in 1 to 3 months.

### 7.4 Charge efficiency

The charge efficiency of Vantex is dependent on the state of charge of the battery and the temperature. For much of its charge profile it is recharged at a high level of efficiency. In general, at states of charge less than 80 % the charge efficiency remains high. When the battery approaches a fully charged condition, the charging efficiency decreases rapidly until fully charged when overcharge begins.

**Figure 3(a): Available capacity after constant voltage charge**

Available charge current $0.1C_5$ A or $0.2C_5$ A, for L type cell.

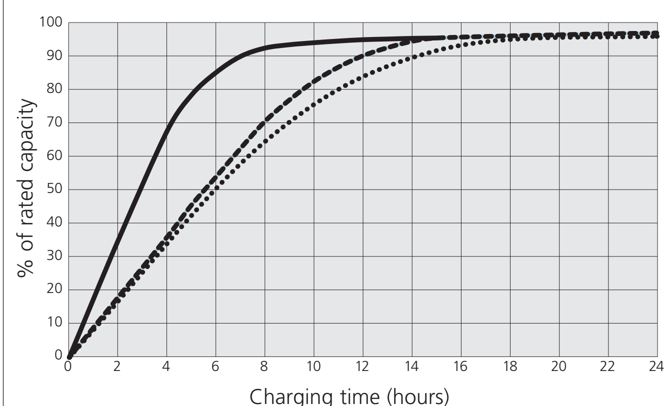



- 1.45 Vpc at + 20°C (+ 68°F), $0.2C_5$ A
- 1.45 Vpc at + 20°C (+ 68°F), $0.1C_5$ A
- 1.42 Vpc at + 20°C (+ 68°F), $0.1C_5$ A

** For charging voltages higher than 1.45 V/cell, a current limit of 0.1 $C_5$A is recommended*

**Figure 3(b): Available capacity after constant voltage charge**

Available charge current $0.1C_5$ A or $0.2C_5$ A, for M type cell.




- 1.45 Vpc at + 20°C (+ 68°F), $0.2C_5$ A
- 1.45 Vpc at + 20°C (+ 68°F), $0.1C_5$ A
- 1.42 Vpc at + 20°C (+ 68°F), $0.1C_5$ A

** For charging voltages higher than 1.45 V/cell, a current limit of 0.1 $C_5$A is recommended*

# 8. Special operating factors

### 8.1 Electrical abuse

#### 8.1.1 Ripple effects

The nickel-cadmium battery is tolerant to high ripple from standard charging systems. Vantex accepts ripple currents up to 0.2 $C_5$ A $I_{eff}$. In general, any commercially available charger or generator can be used for commissioning or maintenance charging of Vantex.

#### 8.1.2 Over-discharge

If more than the designed capacity is taken out of a battery then it becomes over-discharged. This is considered to be an abuse situation for a battery and should be avoided. However, the Vantex battery is designed to recover from this situation.

#### 8.1.3 Overcharge

Overcharge is the effect of forcing current through a battery when it is fully charged.

In the case of Vantex, with its generous electrolyte reserve, a small degree of overcharge will not significantly alter the maintenance period. In the case of excessive overcharge or excessive cycling, water replenishment may be required but there will be no significant effect on the life of the battery.

### 8.2 Mechanical abuse

#### 8.2.1 Shock loads

The Vantex block battery concept complies with IEC 60068-2-29 (bump tests at 5 g, 10 g and 25 g) and IEC 60068-2-77 (shock test 3 g), where *g* = acceleration.

#### 8.2.2 Vibration resistance

The Vantex block battery concept complies with IEC 60068-2-77 where it was subjected to 2 hours at 1 g, where *g* = acceleration.

#### 8.2.3 External corrosion

Vantex nickel-cadmium cells are manufactured in durable polypropylene, all external metal components are nickel-plated and these components are protected by an anti-corrosion oil and a rigid plastic cover.

# 9. Battery sizing principles in stationary applications

There are a number of methods which are used to size nickel-cadmium batteries for standby floating applications. The method employed by Alcad is the IEEE 1115 recommendation which is accepted internationally. This method takes into account multiple discharges, temperature de-rating, performance after floating and the voltage window available for the battery.

A significant advantage of the nickel-cadmium battery is that it can be fully discharged without a significant impact in terms of life or recharge. Thus, to obtain the most cost efficient battery, it is an advantage to discharge the battery to the lowest practical value in order to obtain the maximum energy from the battery.

The principle sizing parameters are:

### 9.1 The voltage window

This is the maximum voltage and the minimum voltage at the battery terminals acceptable for the system. In battery terms, the maximum voltage gives the voltage which is available to charge the battery, and the minimum voltage gives the lowest voltage acceptable to the system to which the battery can be discharged. In discharging the nickel-cadmium battery, the cell voltage should be taken as low as possible in order to find the most economic and efficient battery.

### 9.2 Discharge profile

This is the electrical performance required from the battery for the application. It may be expressed in terms of amperes for a certain duration, or it may be expressed in terms of power (watts or kW) for a certain duration. The requirement may be simply a one step discharge or a many step profile. In order to utilize all of the charged capacity, it’s recommended to discharge the battery until 1.00 V/Cell.

### 9.3 Temperature

The maximum and minimum temperatures and the normal ambient temperature will have an influence on the sizing of the battery. The performance of a battery decreases with decreasing temperature which increases the battery size. Temperature de-rating curves are provided to allow sizing adjustments.

### 9.4 State of charge or recharge time

Some applications may require that the battery shall give a full duty cycle after a certain time after the previous discharge. The factors used for this will depend on the depth of discharge, the rate of discharge, and the charge voltage and current. A requirement for a high state of charge does not justify a high charge voltage if the result is a high end of discharge voltage.

### 9.5 Ageing

Some customers require a value to be added to allow for the ageing of the battery over its lifetime. This may be a value required by the customer, for example 10 %, or it may be a requirement from the customer that a value is used which will ensure the service of the battery during its lifetime. The value to be used will depend on the discharge rate of the battery and the conditions under which the discharge is carried out.

### 9.6 Floating effect

When a nickel-cadmium cell is maintained at a fixed floating voltage over a period of time, there is a decrease in the voltage level of the discharge curve. This effect begins after one week and reaches its maximum in about 3 months. It can only be eliminated by a full discharge/charge cycle, and it cannot be eliminated by a boost charge. It is therefore necessary to take this into account in any calculations concerning batteries in float applications.

This is used in the IEEE sizing method and is included in the published data for Vantex.

As the effect of reducing the voltage level is to reduce the autonomy of the battery, the effect can be considered as reducing the performance of the battery and so performance down-rating factors are used.

Note: for your battery sizing needs, please contact your local sales representative.

# 10. Installation and operating instructions

### Type VTX1 L and VTX1 M

For cells delivered before May 2012, use the Installation and Operating instructions VTX4.1 – April 2008

### Important recommendations

- Never allow an exposed flame or spark near the batteries, particularly while charging.
- Never smoke while performing any operation on the battery.
- For protection, wear rubber gloves, long sleeves, and appropriate splash goggles or face shield.
- The electrolyte is harmful to skin and eyes. In the event of contact with skin or eyes, wash immediately with plenty of water. If eyes are affected, flush with water, and obtain immediate medical attention.
- Remove all rings, watches and other items with metal parts before working on the battery.
- Use insulated tools.
- Avoid static electricity and take measures for protection against electric shocks.
- Discharge any possible static electricity from clothing and/or tools by touching an earth-connected part "ground" before working on the battery.

## 10.1 Receiving the shipment

Do not overturn the package. Check the packages and cells for transport damage.

The battery is shipped filled and charged, and is ready for immediate use.

## 10.2 Storage

Store the battery indoors in a dry, clean, cool location (0°C to +30°C / +32°F to +86°F) and well ventilated space on open shelves.

Storage of a filled battery at temperatures above +30°C (+86°F) can result in loss of capacity. This can be as much as 5 % per 10°C (18°F) above +30°C (+86°F) per year.

Do not store in direct sunlight or expose to excessive heat.

Vantex batteries are supplied filled with electrolyte and charged, they can be stored in this condition for maximum 24 months from date of shipment.

Never drain the electrolyte from the cells.

Store without opening the boxes.

## 10.3 Installation

### 10.3.1 Location

Install the battery in a dry and clean room. Avoid direct sunlight and heat. The battery will give the best performance and maximum service life when the ambient temperature is between +10°C to +30°C (+50°F to +86°F).

### 10.3.2 Ventilation

During the last part of charging, the battery is emitting gases (oxygen and hydrogen mixture). At normal float charge the gas evolution is very small but some ventilation is necessary.

**Note that special regulations for ventilation may be valid in your area depending on the application.**

### 10.3.3. Mounting

Verify that cells are correctly interconnected with the appropriate polarity. The battery connection to load should be with nickel-plated cable lugs. Recommended torques for terminal bolts are:

- M6 = 11 ± 1.1 N.m (97.4 ± 9.8 lbf.in)
- M8 = 20 ± 2 N.m (177.0 ± 17.7 lbf.in)
- M10 = 30 ± 3 N.m (265.0 ± 26.6 lbf.in)

The connectors and terminal should be corrosion-protected by coating with a thin layer of anti-corrosion oil.

### 10.3.4 Electrolyte

When checking the electrolyte levels, a fluctuation in level between cells is not abnormal and is due to the different amounts of gas held in the separators of each cell. There is normally no need to adjust the electrolyte level except if the level is 30 mm below the minimum level mark. The cells have to be topped-up with E22 electrolyte.

Do not top-up prior to initial charge.

After commissioning, when the level is stabilized, it should be not less than 5 mm below the maximum level mark.

## 10.4 Commissioning

Verify that the ventilation is adequate during this operation.

A good commissioning is important. Charge at constant current is preferable. If the current limit is lower than indicated in the table on the Installation and Operating Instructions sheet, charge for a proportionally longer time.

- Cells stored up to 6 months:
  A commissioning charge is normally not required and the cells are ready for immediate use but the full performance will be available only after a long period of charging in service (see section 7.3 Charge acceptance)
- Cells stored more than 6 months and up to 2 years:
  A commissioning charge is necessary:
  - Commissioning at ambient temperature between +10°C to +30°C (+50°F to +86°F)
    - Constant current charge:
    20 h at 0.1 $C_5$ A recommended.

    **Note: At the end of charge, the cell voltage will reach about 1.75 V, thus the charger shall be able to supply such a voltage.**

    When the charger maximum voltage setting is too low to supply constant current charging, divide the battery into two parts to be charged individually at constant current.
    - Constant potential charge:
    1.55 V/cell for a minimum of 24 h, current limited to 0.1 $C_5$ A.
    If these methods are not available, then charging may be carried out at lower voltages, 1.50 V/cell for 36 hours minimum.
  - Commissioning at ambient temperature above +30°C (+50°F)
    - Only constant current charge:
    20 h at 0.1$C_5$ recommended.
    The electrolyte temperature is to be monitored during charge. If the temperature exceeds +45°C (+113°F) during charging, then it must be stopped to reduce the temperature. The charging can be resumed when electrolyte temperature drops below +40°C (+104°F).

Note: When full battery performance is required for capacity test purposes, the battery has to be charged in accordance with IEC 62259 section 7 (7.1 & 7.2).

### 10.5 Charging in service

The recommended charging voltages for continuous parallel operation, with occasional battery discharges, are:

- Two level charge:
  - float level: 1.42 ± 0.01 V/cell
  - high rate (boost) level: 1.45 ± 0.01 V/cell
- Single level charge:
  1.42 ± 0.01 V/cell

To have the full maintenance-free feature in terms of topping-up for high temperature, the correction factor to apply is -2.0 mV/°C (-1.12 mV/°F) starting from an ambient temperature of +20°C (+68°F) (see section 7.2 Temperature compensation).

### 10.6 Periodic maintenance

Vantex is a maintenance-free battery under the recommended operating conditions, from -20°C (-4°F) to +40°C (+104°F) at 1.42 V/cell, with temperature compensation and requires only preventive maintenance.

As a periodic maintenance, the following is recommended:

- Keep the battery clean using only water. Do not use a wire brush or solvents of any kind.
- Check the charging voltage. In parallel operation, it is of great importance that the recommended charging voltage remains unchanged. The charging voltage should be checked at least once yearly. If a cell float voltage is found below 1.35 V, high rate charge is recommended to apply to the cell concerned.
- Check visually the electrolyte level. Never let the level fall below the minimum level mark. Use only distilled or de-ionized water to top-up.

  Topping-up of the Vantex battery shall be carried out when battery is fully charged.

  **Note: There is no need to check the electrolyte density periodically. Interpretation of density measurements is difficult and could be misleading.**
- Check every two years that all connections are tight.
- The connectors and terminal bolts should be corrosion-protected by coating with a thin layer of anti-corrosion oil.
- High water consumption is usually caused by improper voltage setting of the charger.

# 11. Maintenance

In a correctly designed stationary application, Vantex only requires preventive maintenance.

However, it is good practice with any system to carry out an inspection of the system once per year to ensure that the charging system, the battery and the ancillary electronics are all functioning correctly.

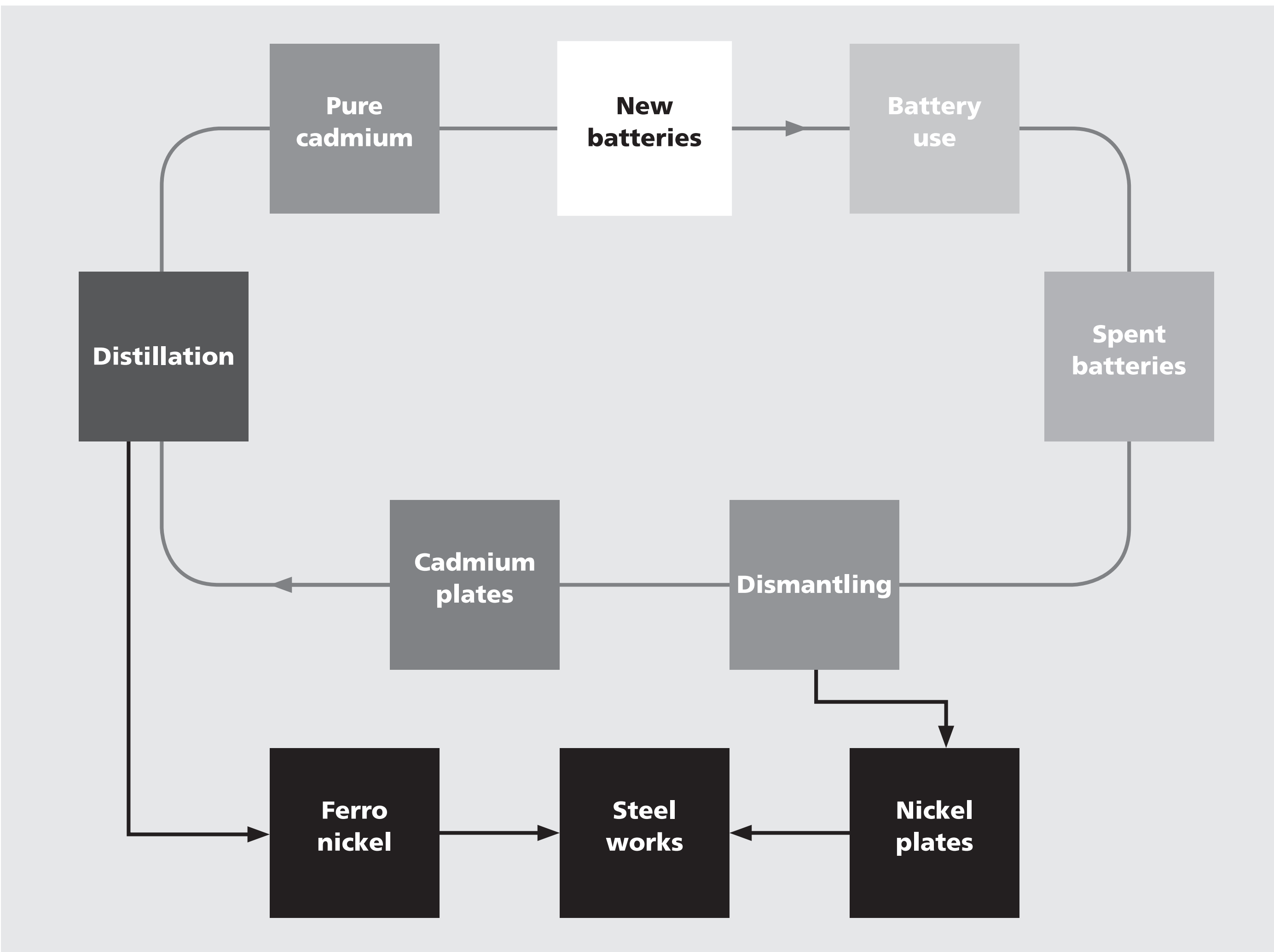
When this system service is carried out, it is recommended that the following actions should be taken:

- Cell electrolyte levels should be checked visually to ensure that the level is above the minimum and if necessary the cells should be topped-up. Use a specific tool to loosen the flame-arresting low pressure vents to release gas pressure and then remove each vent completely and retain for refitting. Use only distilled or de-ionized water.
- The batteries should also be checked for external cleanliness, and if necessary cleaned with a damp brush using water. Do not use a wire brush or solvents of any kind. Vent plugs can be rinsed in clean water if necessary.
- All the connectors must be tight. The connectors and terminal bolts should be corrosion-protected by coating with a thin layer of anti-corrosion oil.

# 12. Disposal and recycling

In a world where autonomous sources of electric power are ever more in demand, Alcad batteries provide an environmentally responsible answer to these needs. Environmental management lies at the core of Alcad's business and we take care to control every stage of a battery's life cycle in terms of potential impact. Environmental protection is our top priority, from design and production through end-of-life collection, disposal and recycling.

Our respect for the environment is complemented by an equal respect for our customers. We aim to generate confidence in our products, not only from a functional standpoint, but also in terms of the environmental safeguards that are built into their life cycle. The simple and unique nature of the battery components make them readily recyclable and this process safeguards valuable natural resources for future generations.




**Standards list:**

- § Certified IEC 62259 - Secondary cells and batteries containing alkaline or other non-acid electrolytes - Nickel-cadmium prismatic secondary single cells with partial gas recombination. Vantex New Generation exceeds gas recombination requirements.
- § Certified IEC 60623 - Secondary cells and battery containing alkaline and other non-acid electrolytes - Vented nickel-cadmium prismatic secondary single cells
- § IEC 60068-2-29 - Environmental testing - Part 2: Tests. Test Eb and guidance: Bump
- § IEC 60068-2-77 - Environmental testing - Part 2-77: Tests - Test 77: Body strength and impact shock
- § IEC 60050-482 - International electro technical vocabulary - Part 482: Primary and secondary cells and batteries
- § Complies with EN 50272-2 / IEC 62485-2 - Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries - The protective covers for terminals and connectors, the insulated cables are compliant with IP2 level protection against electrical shocks according to safety standard.
- § IEEE 1115-2000 - IEEE Recommended practice for sizing Nickel-Cadmium batteries for stationary applications

# Alcad:
# Preserving our planet for the future

Our environmental commitment:

- Using recycled materials ahead of raw materials
- Consistently cutting emissions from our production facilities
- Minimising water consumption
- Reducing fossil fuel usage and $CO_2$ production
- Making provision for battery recycling

# Recycling:
# Making a difference all over the world

We are committed to helping our customers find recycling solutions for depleted batteries. Alcad has long links with collection companies in most EU countries, in North America and all countries where the system can be implemented. Its collection network receives and dispatches customers' batteries at the end of their lives to fully approved recycling facilities, in compliance with the laws governing trans-boundary waste shipments.

Our network of collection companies conforms to the EU batteries directive. All of our collection locations are listed on our web site. In countries where we have thus far been unable to set up collection sites, we assist our customers in seeking out viable recycling options.

For more information, please get in touch with your Alcad sales representative.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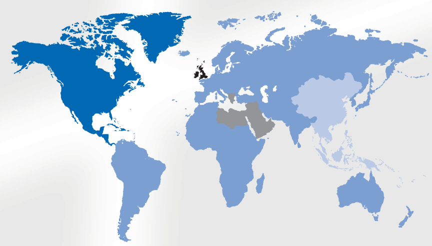

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## Delivering quality

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