

Nickel Cadmium BATTERIES

***POCKET PLATE
STATIONARY BATTERIES***

***INSTALLATION and OPERATING
INSTRUCTIONS***

***Supplied World wide by:
SEC Industrial Battery Co.***

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SECTION 1- PERSONAL SAFETY INFORMATION

WARNING - FOR YOUR HEALTH AND SAFETY

- Always wear goggles and rubber gloves and preferably protective clothing when working on the battery or electrolyte. Remember that the battery electrolyte is corrosive alkaline potassium hydroxide.
- Before working on the battery, check that adequate supplies of clean cold water and saline solution are available. Saline solution should be kept in a squeeze bottle suitable for irrigating the eyes. In the event of contact with electrolyte, the affected skin should be washed with copious amounts of clean cold water. If electrolyte enters the eyes, they should be held open and irrigated with saline solution and then doused liberally with clean cold water. In all cases immediately obtain medical attention.
- Never permit smoking, sparks or any kind of flame near the battery, whether filled or empty, charged or discharged. Remember that battery cells may contain explosive gasses.
- Remember that the battery is electrically live at all times and cannot be isolated in the conventional sense, although voltage at any point can be reduced by removal of appropriate intercell connectors. Steel cell containers must always be considered "live". Battery rooms and /or battery cabinets should be locked against unauthorized personnel. Take care that short circuits are not caused by accidentally dropping or touching metal objects onto cell terminals. Always remove watches and rings before working on a battery.

1.1 Battery Safety Information

WARNING - FOR THE BATTERY'S HEALTH AND SAFETY

- A battery is normally the last line of defence against disaster. Maintenance should reflect the fact that lives may depend on its operation under emergency conditions.
- If in doubt contact SEC Industrial Battery Co. Limited.
- Add only purified water (distilled or deionized), when topping up the battery. Never add any kind of electrolyte or conditioner except under direct instruction from SEC Industrial Battery Co. Limited.
- Store and operate nickel cadmium batteries separate from lead acid batteries. Never work on a battery with tools, which have previously been used on a lead acid battery, this will destroy an alkaline Nickel Cadmium battery.
- Keep the battery clean and correctly filled.
- Check that connections are correctly torqued.

M 5 bolt	4.0 N-m	35in-lbs.
M10 bolt	7.0 N-m	62 in-lb
M16 bolt	11.3 N-m	100 in-lb)
M20 bolt	25.0 N-m	220 in-lb.
- Ensure the charger is maintaining the battery at the recommended voltage.
- Nickel cadmium pocket plate batteries operate at their optimum level when given regular equalizing charges.

All SEC nickel cadmium batteries should be subjected to an equalizing charge every 6 months.

- Periodically (approx. every 24 - 36 months) send a small sample (20 ml) of electrolyte for analysis of potassium carbonate content. SEC Industrial Battery Co. Limited can arrange to carry out this analysis for you on request. Carefully examine the consignment for signs of damage or loss of electrolyte, which may have occurred in transit. If any damage is evident, advise the carriers immediately in writing and send a copy of the letter to SEC Industrial Battery Co. Limited.

Within 14 days of arrival make sure that the consignment is complete and agrees with the packing list included.

Do not discard any accessories with the packing material.

The filling holes in the cell lids will be sealed with special transit plugs, which should be left in position until the battery is ready to be put into service. If cells have been supplied filled, check the electrolyte level in all cells. Abnormally low levels, i.e. below the minimum level, should be reported to SEC Industrial Battery Co. Limited immediately, and to the carrier if there is an evidence of loss of electrolyte in transit.

SECTION 2

2.1 Unpacking

Carefully examine the consignment for signs of damage or loss of electrolyte, which may have occurred during transit. If any damage is evident, advise the carriers immediately in writing and send a copy of the letter to SEC Industrial Battery Co. Limited.

Damaged cells contain alkaline electrolyte and active materials of nickel cadmium and their compounds. The active materials may only be exposed if a cell container is broken. If they are exposed they may evolve heat and could initiate a fire.

Nickel and Cadmium are classified toxic respectively harmful and should be treated accordingly. Any active material should be kept damp and filled into a suitably labeled alkaline resistant container prior to disposal.

Strict personal safety should be observed at all times.

2.2 Storage

The period for which SEC Nickel Cadmium cells can be stored depends on the condition in which they are ordered and supplied.

- Cells supplied filled and charged may be stored for a maximum of 6 months (3 months in tropical climates) from date of despatch from the factory. If, for unavoidable reasons, cells must be stored longer than this, then either:

A) Cells must be given a commissioning charge every 6 (3) months and again prior to commissioning. Electrolyte levels must be checked at the end of the charge and if

necessary, restored to the correct level by the addition of distilled water. OR

B) Cells must be given a commissioning charge, electrolyte adjusted to the correct level, then discharged at a low current, i.e. not greater than a current in amps equal to 10% of the cells C5 capacity, until the terminal voltage of every cell is less than 1.0 volts. After refitting transit plugs, the cells may be stored for 12 months, before the process is repeated. When commissioning cells stored in this way, a cycle of commissioning charge/ discharge should be carried out, followed by a commissioning charge. OR....

C) Cells must be given a commissioning charge then discharge at a low current as (B) but continued to 0.0 volts. Electrolyte should then be drained from each cell by inverting the cell over a suitable container for about 5 minutes. This electrolyte must not be used again. After refitting transit plugs, cells in this condition may be stored indefinitely without further treatment. When commissioning, cells must be filled with new electrolyte and given a cycle of commissioning charge/discharge as in (B), then when finally recharged, the cells may be put into service.

- Cells supplied filled and discharged may be stored under the same condition as (B), or for extended storage should receive the procedure as (C).
- Cells supplied discharged and drained may be stored indefinitely.

Dry electrolyte supplied for discharged and drained cells must be kept dry at all times in airtight containers.

Prior to any period of storage, the exterior of cells should be cleaned and dried and any bright metal parts coated with petroleum jelly.

If cells are to be stored filled, then electrolyte levels should be adjusted towards the end of a period of charge when cells are gassing. This is to allow mixing of any distilled water, which may be added, thus reducing the possibility of the pure water freezing in storage.

Transit plugs should be removed during charging but must be replaced prior to the cells being stored.

Cells should be stored in sealed, polyethylene bags with silica gel desiccant, in a clean dry area and should not be subjected to temperatures normally outside the range of 0C to 40C.

Electrolyte is corrosive and proper arrangements should be made for its disposal if emptied from cells. If required, and provided that the material is delivered to us properly packed in suitable containers, SEC Industrial Battery Co. Limited will undertake to process the waste material for a nominal charge.

SECTION 3-Commissioning

3.1 Mixing of Dry Electrolyte

If cells have been supplied and/or stored in a discharged and drained condition, it will be necessary to mix a fresh supply of electrolyte.

Packages of dry electrolyte should remain sealed until actually required for use. Only distilled water should be used for the mix. Approximately 3 liters of distilled water will be needed for each kg of dry electrolyte.

CAUTION: Electrolyte is corrosive and the operator MUST wear goggles and rubber gloves and preferably protective clothing.

The quantities of dry electrolyte required for each cell type are shown below.

3.2 Mixing Vessel

The mixing vessel has to be able to meet two requirements. Firstly, it must not contaminate the electrolyte and secondly, it must be able to withstand the considerable heat generated during the mixing process.

Plastic containers, while not likely to contaminate the electrolyte, are usually unable to withstand the 40C+ heat generated during the mixing process and are, therefore, unsuitable.

Copper, aluminum, any galvanized or tinned vessels or vessels with soldered joints will contaminate the electrolyte and therefore must not be used. Plain iron, steel or stainless steel vessels are ideal providing they are clean and in good condition.

The size of the vessels should reasonably correspond with the largest size of pack of electrolyte supplied so that the total electrolyte in any pack may be mixed at one time.

Standard pack sizes of dry electrolyte are 25kg or as specified/required by customers. Dry electrolyte will be supplied for each battery ordered in a combination of these pack sizes:

Total quantity of dry electrolyte
Minimum size of mixing

Required for each battery:	Container	
Less than 12½ kg	20 liters	5 Gal.
Less than 25 kg	40 liters	10 Gal.
More than 25 kg	100 liters	25 Gal.

CELL TYPE	NOM (Ah) DRY ELECT.	
	C/5 RATE	Per CELL (KG)
KL 11P	11	0.077
KL 18P	18	0.118
KL 24P	24	0.094
KL 30P	30	0.089
KL 40P	40	0.211
KL 45P	45	0.211
KL 55P	55	0.185
KL 65P	65	0.161
KL 80P	80	0.469
KL 100P	100	0.441
KL 120P	120	0.429
KL 140P	140	0.385
KL 150P	150	0.530
KL 160P	160	0.987
KL 185P	185	0.882
KL 200P	200	0.882
KL 230P	230	0.794
KL 270P	270	0.708
KL 300P	300	0.621

KL 340P	340	1.252
KL 370P	370	1.192
KL 400P	400	1.132
KL 435P	435	1.072
KL 470P	470	1.012
KL 520P	520	1.782
KL 560P	560	1.734
KL 600P	600	1.927
KL 650P	650	3.902
KL 740P	740	3.757
KL 840P	840	3.612
KL 1000P	1000	2.890
KL 1250P	1250	3.010
KL 1500P	1500	3.191

KM 11P	11	0.077
KM 18P	18	0.106
KM 24P	24	0.094
KM 30P	30	0.089
KM 40P	40	0.212
KM 48P	48	0.185
KM 55P	55	0.161
KM 65P	65	0.310
KM 75P	75	0.294
KM 90P	90	0.438
KM 110P	110	0.378
KM 125P	125	0.496
KM 140P	140	0.434
KM 160P	160	0.889
KM 185P	185	0.821
KM 205P	205	0.698
KM 225P	225	0.674
KM 250P	250	0.626
KM 270P	270	1.252
KM 300P	300	1.204
KM 320P	320	1.154
KM 340P	340	1.084
KM 355P	355	1.036
KM 380P	380	0.987
KM 400P	400	0.915
KM 450P	450	1.301
KM 520P	520	1.806
KM 600P	600	3.661
KM 675P	675	3.733
KM 750P	750	3.372
KM 1000P	1000	3.468
KM 1250P	1250	4.335

KH 10P	10	0.121
KH 20P	20	0.082
KH 30P	30	0.186
KH 40P	40	0.147
KH 50P	50	0.222
KH 50P	50	0.390
KH 65P	65	0.340
KH 80P	80	0.289
KH 90P	90	0.633
KH 100P	100	0.612
KH 125P	125	0.541
KH 150P	150	0.819
KH 185P	185	1.373
KH 200P	200	1.296
KH 235P	235	1.173

3.3 Mixing of Electrolyte

CAUTION: When handling electrolyte always wear eye protection and rubber gloves. Never add water to dry electrolyte, always add dry electrolyte to water already in the mixing vessel.

Pour into the mixing vessel 2-3 liters (0.5 Gal.) of distilled water for every kg of dry electrolyte to be mixed. Slowly add the dry electrolyte, stirring all the time with a steel rod. Take care not to cause splashes. The solution will become very hot but should be thoroughly mixed and then left to cool. While cooling, cover the container to avoid contact between the electrolyte and air, taking care that the material of the cover will not contaminate the electrolyte.

When the electrolyte is cool, measure the SG with a hydrometer and the temperature of the electrolyte with a thermometer. The reading of the hydrometer should be corrected for temperature as follows:

ELECT. TEMP. °C	SUBTRACT (-) FROM READING	ELECT. TEMP. °C	ADD (+) TO READING
0	-0.010	20	0.000
2	-0.009	22	0.001
4	-0.008	24	0.002
6	-0.007	26	0.003
8	-0.006	28	0.004
10	-0.005	30	0.005
12	-0.004	32	0.006
14	-0.003	34	0.007
16	-0.002	36	0.008
18	-0.001	38	0.009
		40	0.010

(For example, SG reading of 1.198 is taken at an electrolyte temperature of 40C when corrected to 20C is 1.208 (1.198 + 0.010).

The corrected SG of the mix at this stage will be higher than the required 1.190/1.200 and therefore, a small quantity of distilled water should be added. After stirring well, take another SG reading and again correct for temperature. If the corrected reading is still over 1.200 add a further small quantity of distilled water and continue the process until a corrected SG reading of between 1.190 and 1.200 is obtained.

Allow any sediment to settle in the mixing tank then the electrolyte is ready for use.

3.4 Filling the Cells

Before filling cells, the special transit plugs should be removed and disposed of. In the case of steel cells, the plug is a rubber bung located inside the vent plug and, in plastic cells is a plastic cap fitted in place of the vent plug.

Care must be taken that any sediment at the bottom of the mixing tank is not disturbed during the filling process. Enough dry electrolyte has been supplied to ensure all the cells are filled even if some electrolyte is left at the bottom of the mixing tank with any sediment.

Cells may be filled either before or after location on battery stands, whichever is more convenient.

Electrolyte may be pumped or siphoned from the mixing tank either directly into the cells or if now cool into a plastic jug for filling the cells. Do not scoop up electrolyte directly from the tank into another containers as this may disturb any sediment in the tank.

CAUTION: Never start the siphon by sucking the end of the siphon tube, severe injuries can result.

The approximate volume of electrolyte per Cell is shown in the table below.

Fill plastic cells up to the maximum level line shown on the outside of the container and steel cells up to the maximum level on the level tube. **DO NOT OVERFILL** as this will cause high specific gravities and consequential damage in later service when electrolyte falls to the correct level through loss of water.

Clean and dry the exterior of all cells using only water with a little detergent added. Lightly coat the terminal bolts and nuts, removing nuts and intercell connectors if cells are already made up into blocks or crates, with petroleum jelly to inhibit corrosion.

The cells are now ready for assembly into place on battery stand or into the appropriate cubicle.

CELL TYPE	NOM (Ah) C/5 RATE	VOLUME OF ELECTROLYTE (L)
KL 11P	11	0.27
KL 18P	18	0.41
KL 24P	24	0.33
KL 30P	30	0.31
KL 40P	40	0.73
KL 45P	45	0.73
KL 55P	55	0.64
KL 65P	65	0.56
KL 80P	80	1.63
KL 100P	100	1.53
KL 120P	120	1.48
KL 140P	140	1.33
KL 150P	150	1.83
KL 160P	160	3.42
KL 185P	185	3.05
KL 200P	200	3.05
KL 230P	230	2.75
KL 270P	270	2.45
KL 300P	300	2.15
KL 340P	340	4.33
KL 370P	370	4.13
KL 400P	400	3.92
KL 435P	435	3.71
KL 470P	470	3.50
KL 520P	520	6.17
KL 560P	560	6.00
KL 600P	600	6.67
KL 650P	650	13.5
KL 740P	740	13.0
KL 840P	840	12.5
KL 1000P	1000	10.0
KL 1250P	1250	10.4
KL 1500P	1500	7.58
KM 11P	11	0.27
KM 18P	18	0.37
KM 24P	24	0.33
KM 30P	30	0.31
KM 40P	40	0.73
KM 48P	48	0.64
KM 55P	55	0.56
KM 65P	65	1.08
KM 75P	75	1.02
KM 90P	90	1.52
KM 110P	110	1.31
KM 125P	125	1.72
KM 140P	140	1.50
KM 160P	160	3.08

KM 185P	185	2.84
KM 205P	205	2.42
KM 225P	225	2.33
KM 250P	250	2.17
KM 270P	270	4.33
KM 300P	300	4.17
KM 320P	320	4.00
KM 340P	340	3.75
KM 355P	355	3.58
KM 380P	380	3.42
KM 400P	400	3.17
KM 450P	450	4.50
KM 520P	520	6.25
KM 600P	600	12.7
KM 675P	675	12.9
KM 750P	750	11.7
KM 1000P	1000	12.0
KM 1250P	1250	15.0
KH 10P	10	0.42
KH 20P	20	0.29
KH 30P	30	0.64
KH 40P	40	0.51
KH 50P	50	0.77
KH 50P	50	1.35
KH 65P	65	1.18
KH 80P	80	1.00
KH 90P	90	2.19
KH 100P	100	2.12
KH 125P	125	1.87
KH 150P	150	2.83
KH 185P	185	4.75
KH 200P	200	4.48
KH 235P	235	4.06

SECTION 4

General Installation Information

When assembling cells into batteries, make all the short intercell connection first, make the inter-row on inter-tier connections next and lastly only make connections to the charger or load having made sure that the battery is isolated elsewhere from both charger and load.

When working on a battery having a large number of cells, put cells into position and bolt on inter-cell connectors to ensure correct positions, but then remove a connector every 10th cell or so to prevent the high voltage building up as more cells are connected.

Working on a high voltage connection could be dangerous if any part of the battery is earthed either accidentally or deliberately. Once all cells are in position, check insulation of each section to earth and the voltage of each section (10 cells = 12 volts nominal) and if good, replace the missing connectors and then inter-row connectors and finally, the main connections to charger and load.

When high voltage batteries are installed in cabinets, it is preferable if the cabinets are lockable.

It is preferable if a "permit to work" system is employed for installation and maintenance of any high voltage batteries.

Take great care not to allow metal objects to short circuit connectors or terminal pillars of opposite

polarity of between connectors or pillars and cell case if the cell has a steel case.

4.1 Steel Case Cells

Depending on their design, all steel cased cells have an electrical conductive connection to the steel case caused by the electrolyte. Therefore a voltage potential can be measured between cell cases and terminal or connectors.

Cells should be mounted on the insulators provided. The steel cased cell, even when protected, must be considered live and if cells are mounted in steel cabinets, adequate precautions must be taken to ensure insulation between adjacent cell cases and between cell cases and cabinets both during assembly and throughout service life.

Care should be taken to ensure a gap of 15mm between adjacent steel cells, although inter-cell connectors provided will normally ensure adequate spacing between cells in the same row.

After all cells are in position, check the position of the hinge vent plugs and if necessary, remove and refit vent plugs so that none of the hinges are positioned to the front of the battery. This will help to make subsequent maintenance easier. The complete plastic vent plug is fitted into the cell with a bayonet fixing and can be removed and turned through 180 degrees before refitting.

4.2 Plastic Cells

At low voltages the plastic case itself is a sufficient insulator for most applications. In special cases or for high voltage batteries, insulators will be supplied and cells should be mounted on these. Cells should be arranged so that the lines imprinted on the container indicating minimum and maximum levels of electrolyte are clearly visible.

After the cells are installed and all connections made secure, the battery is ready for its commissioning charge.

SECTION 5

Commissioning Charge

A commissioning charge has to be carried out before setting a Nickel Cadmium battery into operation.

Before applying any charging voltage remove the **Transport/ Storage Plugs**, except in the KPL 10P cells, the **Upper Black Rubber Seal** from the central screw should be removed.

Where conditions do not permit continuous working, the charge (and discharge where required) may be split into sections, with a rest period between, providing that the total duration of charge/discharge is as specified.

Essentially, the commissioning charge is designed to ensure that all cells are in a fully charged state, in good condition and in balance with each other. This is necessary even if the battery is eventually to be operated in a partly charged condition. It is advisable for the commissioning charge to be carried out with the load isolated from battery/charger and is

essential if the high voltage may damage the load developed during commissioning.

The room should be well ventilated during the commissioning charge and particular care taken to exclude any means by which gas given off during charge might be ignited.

5.1 Type of Charger

Chargers with *W* (Constant Current) or *IU* Characteristics (Constant Float Voltage Chargers)

Chargers must be capable of raising the cell voltage to 1.70 volts per cell. Where battery and charger have been supplied for operation on a system with close voltage limits, then a special facility should have been incorporated into the charger to allow the high commissioning voltage to be developed. Often this facility is brought into circuit by an internal two-position switch marked: "AUTO" - "COMMISSION".

Irrespective of the current limit of the charger, the commissioning charge should be for a minimum time of 30 hours. Towards the end of charge a voltmeter should be used to check the voltage of each individual cell.

The battery is equalized and full charged when all cell voltages have stabilized over consecutive hourly readings. Pay particular attention to any cells that have much lower voltages than others and if continued charging does not bring these cells approximately into line with the others, seek further advice from SEC Industrial Battery Co. Limited. Check battery electrolyte temperature frequently, preferably in a center cell, and if it exceeds 40C, stop the charge and allow the battery to cool before recommencing charging again.

Electrolyte level must be checked at the end of the charge.

Other Types of Chargers

Where the commissioning charge is from a constant current or manually controlled charger, i.e. when the system charger is unsuitable for carrying out the commissioning charge or is of a special type, then the charge can be carried out at a current in amps equal to 20% of the 5 hour rated capacity. The charge must be continued for at least 15 hours, cell voltages must stabilize over consecutive hourly readings and must be over 1.6 volts per cell. Note that the charging current must be the same at each reading or voltages will not be equivalent due to differing ohmic drop.

5.2 Cells Supplied Filled and Charged

Commissioning charge should be done according to one of the following procedures:

- A) Charging with modified constant voltage of 1.55 to 1.6 volts per cell. Charge for a minimum of 15 hours.
- B) Charging with constant current of $I/5$. Charge for a minimum of 8 hours.
- C) Other charging conditions. Charge until a minimum capacity input of 150% has been achieved.

5.3 Cells Supplied Filled and Discharged

Commissioning charge should be done according to one of the following procedures:

- A) Charging with modified constant voltage of 1.55 to 1.6 volts per cell. Charge for a minimum of 30 hours.
- B) Charging with constant current of I/5. Charge for a minimum of 15 hours.
- C) Other charging conditions. Charge until a minimum capacity input of 300% has been achieved.

5.4 Cell Supplied Unfilled and Deep Discharged

Charge in a similar manner to details in section 5.2.

Additional Procedure for Batteries Filled After Leaving the Factory

Batteries filled on site should, following the first commissioning charge above, be discharged to 1.0 volts per cell at 10% of the C/5 rate and then a second commissioning charge carried out as above. If equipment sensitive to voltage is used as a discharge load, check that the battery voltage has fallen to a safe level after the end of the charge before connecting or switching in the discharge load.

After the commissioning charge leave the cells to stand for one hour to allow gas to dissipate, then top up the cells with more electrolyte. Top up plastic cells to the maximum level shown on the outside of the container and steel cells to the maximum level indicated by the level tube - **Do not overfill.**

Electrolyte will never be added to cells again. To prevent incorrect use and/or possible accidents, any remaining mixed or dry electrolyte should be safely disposed of.

Proper precautions should be taken to dispose of the excess electrolyte remembering that the material is corrosive and could cause injury. If in doubt, properly pack and return the material to SEC Industrial Battery Co. Limited for disposal.

Batteries are now ready for service. **Remember to return the charger-commissioning switch to "AUTO".**

SECTION 6-Maintenance in Service

CAUTION - USE PROTECTIVE CLOTHING - ELECTROLYTE IS CORROSIVE

6.1 Routine Maintenance

Basically maintenance in service consists of keeping the electrolyte level within the maximum and minimum levels and keeping cells, connectors, stands and crates clean and dry. Enter reading of voltage, specific gravity and usage of distilled water in the logbook provided.

6.2 Maintenance Tools

A set of tools is supplied with every battery. These comprise:

Hydrometer
Thermometer (only when dry cells are supplied)
Box Spanner
Funnel
Safety Card
Log Book / I & O Manual

Never use the same tools on Lead Acid and Nickel Cadmium batteries.

Available as optional extras is a boxed kit of eyewash solution.

6.3 Electrolyte

The electrolyte is a dilute solution of potassium hydroxide with a small addition of lithium hydroxide. At a temperature of 20C and with the cell topped up to the maximum recommended level, the specific gravity (SG) should be between 1.190 and 1.200.

The electrolyte does not take part in the chemical changes, which take place as the battery is charged and discharged. The specific gravity is not, therefore, an indicator of the state of charge of the battery. Neither does the specific gravity of the electrolyte change significantly with increases in carbonate content (see the section on electrolyte changes).

Specific gravity of electrolyte does vary however, as a result of three different conditions:

a. Electrolyte levels

Electrolyte level falls in service because the charge current splits the water in the electrolyte into its constituent elements of hydrogen and oxygen. Only water is lost from the electrolyte by this process and as the level of the electrolyte falls, the specific gravity of the solution increases. Returning water to the cell by topping up with distilled water reduces the specific gravity again until the normal reading is again obtained with the electrolyte at the maximum recommended level.

b. Temperature

Specific gravity must always be related to a reference temperature. SEC Industrial Battery Co. Limited uses 20C as this reference temperature for the Nickel Cadmium electrolyte. If an electrolyte at 20C has a specific gravity of 1.200 and is warmed, the specific gravity will decrease. This is because the volume of electrolyte will increase in proportion to the increased temperature while the mass remains constant. At 30C this same electrolyte will have a specific gravity of 1.195 and at 40C of 1.190. Conversely as the temperature is reduced from 20C, the specific gravity will increase. At 10C this same electrolyte has a specific gravity of 1.205 and at 0 C of 1.210.

c. Loss of electrolyte

As the charge current splits water into hydrogen and oxygen, small bubbles of these gases rise through the electrolyte to burst on the surface and eventually the gases escape the cell through the vent cap. During this process, very tiny amounts of electrolyte form a fine mist within the cell and, although vent

caps are designed to trap and return most of this mist to the cell, very small amounts do escape.

Over very long periods of time - many years - this loss of electrolyte, with a specific gravity of about 1.200m, and its constant replacement with water (SG of 1.000) lead to a reduction in the specific gravity of the electrolyte remaining within each cell.

6.4 Taking Specific Gravity Readings

Specific gravity readings are necessary at only infrequent intervals, as they do not indicate the state of charge or condition of a cell. When taken, the points mentioned in paragraph a, b and c above should be borne in mind. The electrolyte should always be at the maximum recommended level, well mixed and the electrolyte temperature should be known at the time the SG reading is taken. The correction factors previously mentioned should be used to correct specific gravity readings taken at temperatures other than 20 C.

If the battery has recently been topped up to the maximum level, it should be allowed to gas to mix the electrolyte before a specific gravity reading is taken, otherwise the liquid drawn into the hydrometer will be mostly the water recently added to the cell and a true reading will not be obtained.

6.5 Topping Up

Cells should be topped up only with distilled water that has been checked for acidity with an indicator paper. If any acidity at all is apparent the water must not be used.

Top up cells in plastic containers to the maximum level indicated on the container - **DO NOT OVERFILL.**

Use a glass level tube to check the level of electrolyte in steel cells. **TAKE CARE AND REMEMBER THAT ELECTROLYTE IS CORROSIVE.** Place the graduated end of the tube into the cell until it touches the top of the plates - do not push against the plates. Hold the tube vertically and close the end of the tube projecting out of the cell with your thumb. Keeping the end of the tube closed, remove the tube from the cell. The level of electrolyte in the tube indicated the level of electrolyte above the plates. The topmost graduation on the tube represents the maximum recommended level to which the cell should be filled with distilled water. Return the electrolyte in the tube to the cell. Top up with small amounts of distilled water, checking the level after each addition.

DO NOT OVERFILL.

Use a closed and graduated container to store distilled water and estimate the total amount of water put into the battery on each occasion. Note the amount of water used in the logbook.

Over a period, change in water consumption will give a good indication of the condition of both battery and charger. Changes in average water consumption should be investigated - check charge rate etc.

6.6 Cleaning the Battery

Isolate the battery from both charger and load and remove inter-cell connectors at intervals to ensure safe working voltages.

The battery should be sited in a clean and dry area. Care should be taken when topping up that there are no spills of electrolyte or distilled water. As and when necessary, steel and plastic cells can be cleaned with plain tap water with a little detergent added.

If contamination is very heavy, it is better to dismantle the battery and clean cells, crates and stands separately. Steel cell containers are both nickel plated and finished with paint. It is therefore, unlikely that repairs other than cleaning will be required by either plastic or steel-cased cells.

If the battery is dismantled do not remove or adjust the lock nut nearest the cell lid. This is set to compress the sealing gland and electrolyte leakage may occur later if it is disturbed

6.7 Electrolyte Changes

Potassium hydroxide electrolytes slowly absorb carbon dioxide from the air. The gas forms compounds within the electrolyte, which increase the internal resistance of the cell and hence reduce performance. Normally, absorption of carbon dioxide takes many years to have a serious effect on performance, but is more rapid if batteries are operated at high temperatures or in environments with unusually high concentrations of carbon dioxide, i.e. from engine exhaust, etc. The reduction in performance is not permanent and the cell can be returned to good condition by renewing the electrolyte. SEC Industrial Battery Co. Limited recommends that electrolyte be changed if the potassium carbonate content reaches 75 grams per litre of electrolyte.

The only way to determine the carbonate contents is by chemical analysis, it is suggested that this is carried out every 2 or 3 years. Any good laboratory can carry out the analysis or SEC Industrial Battery Co. Limited will be pleased to arrange for the test to be done for you.

A 20ml sample of electrolyte should be made up in a small plastic bottle, using small amounts of electrolyte from the cells in the battery. Do not take the whole sample from one cell. Take the sample when the battery has been fully topped up and after charging to mix any recent additions of distilled water. Seal the sample bottle tightly, pack carefully and send to SEC Industrial Battery Co. Limited where it will be dispatched to the laboratory. Please enclose details of the battery from which the sample was taken. The details required are battery serial number, type and number of cells and the date of commissioning.

If the analysis shows that an electrolyte change is required, order from SEC Industrial Battery Co. Limited the correct quantity of dry electrolyte plus a 10% excess to allow for spills and waste. Once the electrolyte has been received and arrangements have been made for the battery to be out of service for a day or two, proceed as follows.

WEAR PROTECTIVE CLOTHING, GLOVES AND GOGGLES

Discharge the battery at a current equal to 10% of the 5-hour capacity until the voltage of **each** cell is less than 0.4V.

Then isolate the battery from both charger and load and disconnect all inter-cell connectors. Provide sufficient containers (steel or plastic) to hold the entire electrolyte contained in the battery. Remove each cell from the stand or cabinet and up end them to drain the entire electrolyte into the containers. Leave each cell to drain for 5 minutes over the container, then clean the outside of each cell with clean water and detergent and dry before draining the next.

The procedure from there on is the same as if the cells were being filled for the first time. See instructions for filling the cells.

THE OLD ELECTROLYTE IS CAUSTIC AND THEREFORE DANGEROUS. DISPOSE OF IT IN A RESPONSIBLE AND SAFE MANNER.

SECTION 7-Test Procedures

The following procedures may be used to determine the potassium hydroxide and potassium carbonate content of the electrolyte if desired. Either method may be used.

7.1 Determination of KOH and K₂ CO₃ in the Electrolyte

CHEMICALS

Trade Name	Chemical Designation	Chemical Formula
Caustic potash	Potassium hydroxide	KOH
Distilled water	Distilled water	H ₂ O
Potash lye	Potassium hydroxide sol.	KOH+H ₂ O
Boric acid sol.	Boric acid solution	H ₃ BO ₃ +H ₂ O
Hydrochloric acid	Hydrochloric acid	HCl
Ekalit	KOH with added lithium	KOH+LiOH

Test box, complete, comprising:

- 1 No. 5 ml graduated pipette and rubber bulb pipette filler
- 1 No. 50 ml dropping bottle, filled with phenolphthalein (reagent A)
- 1 No. 50 ml dropping bottle, filled with methyl orange (reagent B)
- 1 No. Erlenmeyer flask, pyrex glass, capacity 500 ml
- 1 No. 1000 ml one mark volumetric flask, pyrex glass with stopper
- 1 No. glass funnel, 50 mm diameter
- 1 No. washing bottle 1000 ml (PVC), filled with distilled water
- Pack of NCVS hydrochloric acid septum vials, each to make 1000 ml of 1 N hydrochloric acid solution
- 1 No. eye-wash bottle, filled with saline solution
- 1 pair of goggles
- 1 pair of rubber gloves
- 1 hydrometer with scale indicating specific gravity 1.0 - 1.5
- 1 Schellbach burette, blue line and enamelled back, with single bore stop cock, class B, capacity 25 ml in 0.1 ml increments.

7.1.1 Making 1 N HCl

Place the contents of one septum vial of NCV hydrochloric acid in a 1000 ml volumetric flask. Rinse the empty septum vial with distilled water 2 or 3 times and empty this water also into the volumetric flask. Top up the 1000 ml volumetric flask with distilled water up to the mark and mix it well (by shaking several times).

Transfer the 1 N HCl thus produced (1 litre in the measuring flask) into a storage bottle and fill the burette for titration.

7.1.2 Determining the Potassium Carbonate Content

Fill the titrating burette with 1 N hydrochloric acid up to the zero point. Using a pipette, introduce 5 ml of potassium hydroxide into the Erlenmeyer flask and dilute it with approximately ten times the quantity of distilled water. Now add a few drops of reagent A (phenolphthalein) which will cause the solution to change its colour into violet. Whilst shaking this Erlenmeyer flask carefully, let the hydrochloric acid flow slowly from the burette until the solution becomes colourless. Read the quantity of hydrochloric acid used on the burette, note it and mark it with a "p".

Now add to the colourless solution a few drop of reagent B (methyl orange). This will change the colour of the solution to yellow. Subsequently, keep shaking the Erlenmeyer flask carefully and keep adding hydrochloric acid slowly from the burette to the yellow solution until it changes its colour to orange. Check the quantity of hydrochloric acid used on the burette and note it as value "m". The content of potassium carbonate in one litre of electrolyte is established with the aid of the following equation:

$$(m-p) \times 2 \times 69.1/5 = [K_2CO_3 / 1]$$

Example:

Quantity of hydrochloric acid used before the solution becomes colourless: 20 ml (value p). Total quantity used for changing from yellow to orange: 20.7 ml (value m).

Calculation:

$$(m-p) \times 2 \times 69.1/5 = (20.7-20) \times 2 \times 13.8 = 19.3g K_2CO_3 / 1$$

When using table 1, we only need to have the difference m-p, which will allow us to find the respective amount of potassium carbonate in one litre of potassium hydroxide in column C1.

In the example, we have m-p = 0.7, the respective value in column C1 of Table 1 is 19.3g K₂CO₃/1.

7.1.3 Determining the Electrolyte Density

Density is calculated from the titration values of the carbonate calculation with the aid of the following formula:

$$[p-(m-p)] \times 56.1/5 = gKOH/1$$

Example:

The above potassium carbonate calculation gave us: p = 20 ml and the difference m-p=0.7 ml.

By inserting these values into the equation we have:

$$[p-(m-p)] \times 56.1/5 = 20 - (0.7) \times 11.2 = 19.3 \times 11.2 = 216.2 \text{g KOH/1}$$

By using Table 2 we only need to know the difference of $p-(m-p)$, which will allow us to find the respective value for the electrolyte density in g KOH/1, %KOH or g/cu.cm. In column C2. In the example, we have $p-(m-p)=19.3$. Parallel values in column C2 of Table 2 obtained by interpolation are 216.5g KOH/1, 18.45% KOH and 1.173 g/cu.cm. Without having to interpolate we can find from Table 2 that the concentration is between 212.03 and 225.89g KOH/1 or 18.12 and 19.14% or 1.17 and 1.18g/cu.cm Generally this accuracy is sufficient, therefore interpolation is not necessary.

7.2 Determination of KOH and $K_2 CO_3$ in Electrolyte - Alternative Method

Equipment:	Erlenmayer flask, cap.500ml
	Graduated pipette, cap.5 ml Titrating burette, cap. 50ml
Reagents:	Hydrochloric acid, HCl, 1 N Distilled Water Phenolphthalein 1%
alcoholi	Methyl orange reagent

Analysis Procedure

Fill the titrating burette with 1 N hydrochloric acid up to zero point. Using a pipette introduce 5 ml of potassium hydroxide into the 500 ml Erlenmayer flask and dilute it with approximately 50-100 ml of distilled water.

Now add 3-5 drops of phenolphthalein, which will cause the solution to change its colour to violet. Whilst shaking this Erlenmayer flask carefully, let the hydrochloric acid flow slowly from the burette until the solution becomes colourless. Read the quantity of hydrochloric acid used on the burette, note it and mark it with "Consumption 1" (C1).

Now add to the colourless solution 3-4 drops of methyl orange reagent, which will change the colour of the solution to yellow. Subsequently keep shaking the Erlenmayer flask carefully and keep adding hydrochloric acid slowly from the burette until it changes its colour to orange. Check the total quantity of hydrochloric acid used on the burette, note it and mark it with "Consumption 2" (C2).

Calculation:

$K_2 CO_3$ contents:

$$2 \times (C2-C1) \times FK_2 CO_3 / 5 = g K_2 CO_3 / 1 \text{ where}$$

$$FK_2 CO_3 = 69,107$$

KOH contents:

$$(2C1-C2) \times FKOH/5 = g KOH/1 \text{ where}$$

$$FKOH = 56,109$$

TABLE 1

M-P 1 N ACID (ML) $K_2 CO_3$	C1 GR/LIT	M-P 1N ACID (ML) $K_2 CO_3$	C1 GR/LIT
0.1	2.8	2.6	71.8
0.2	5.6	2.7	74.5
0.3	8.3	2.8	77.3
0.4	11.0	2.9	80.0
0.5	13.8	3.0	82.8
0.6	16.6	3.1	85.6
0.7	19.3	3.2	88.3
0.8	22.1	3.3	91.1
0.9	24.8	3.4	93.8
1.0	27.6	3.5	96.6
1.1	30.4	3.6	99.4
1.2	33.1	3.7	102.1
1.3	35.9	3.8	104.9
1.4	38.6	3.9	107.6
1.5	41.1	4.0	110.4
1.6	44.2	4.1	113.2
1.7	46.9	4.2	115.9
1.8	49.7	4.3	118.7
1.9	52.4	4.4	121.4
2.0	55.2	4.5	124.2
2.1	58.0	4.6	127.0
2.2	60.7	4.7	129.7
2.3	63.5	4.8	132.5
2.4	66.2	4.9	135.2
2.5	69.0	5.0	138.0

TABLE 2

P-(M-P) 1N ACID	KOH GR/LIT	KOH %	DENSITY GR/CCM
5.17	57.98	5.52	1.05
6.24	69.99	6.60	1.06
7.32	82.14	7.68	1.07
8.42	94.45	8.75	1.08
9.51	106.73	9.79	1.09
10.65	119.50	10.86	1.10
11.79	132.27	11.92	1.11
12.94	145.25	12.97	1.12
14.23	158.54	14.03	1.13
15.30	171.80	15.07	1.14
16.49	185.03	16.09	1.15
17.68	198.38	17.10	1.16
18.90	212.03	18.12	1.17
20.14	225.89	19.14	1.18
21.38	239.90	20.16	1.19
22.63	253.94	21.16	1.20
23.91	268.24	22.17	1.21
25.31	282.53	23.16	1.22
26.47	297.01	24.15	1.23
27.77	311.58	25.13	1.24
29.09	326.34	26.11	1.25
30.35	341.46	27.10	1.26
31.75	356.49	28.07	1.27
33.09	371.20	29.00	1.28
34.44	386.39	29.95	1.29
35.80	401.65	30.90	1.30
37.17	417.09	31.84	1.31
38.36	432.64	32.78	1.32
39.96	448.34	33.71	1.33

11 TECHNICAL SUPPORT

*SEC is always ready to assist you in your installation and operation of SEC **Nickel Cadmium pocket plate** batteries. If you have any questions on any portion of this manual, please do not hesitate to call or fax any of our offices listed below and request assistance.*

SEC Industrial Battery Co. Ltd.

Thorney Weir House
Iver, Bucks, SLO 9AQ,
United Kingdom.
Tel.: 44-1895-431543
Fax.: 44-1895-431880
SEC Website: www.secbattery.com
Email: brian.harper@secbattery.com

SEC European Sales Office

42 rue de la Rochette
77000 Melun
France.
Tel.: +33 675 590 692
SEC Website www.secbattery.com
Email: Christian.dhainaut@secbattery.com

SEC Industrial Battery Co. BSC

P.O. Box 32225,
Kingdom of Bahrain
Tel.: 97317-721322
Fax.: 97317-740743
SEC Website: www.secbattery.com
Email: sujo.pulikottil@secbattery.com

SEC Industrial Battery Co. Ltd.,

Unit 6, 6F Hewlett Centre,
No.54 Hoi Yuen Road, Kwun Tong
Kowloon, Hong Kong.
Tel.: 852-230 44382
Fax.: 852-230 44013
SEC Website: www.secbattery.com
Email: duncan.low@secbattery.com

SECTION 9 - BATTERY REPORT

SEC NICKEL CADMIUM BATTERY REPORT

Installed by: Representative:
 Operating Company: Date: Time:
 Address/Location:

Battery Information

Type of Battery: No. of Cells/String: String Float Voltage:
 Installation Date: No. of Strings/Battery: Float Voltage/Cell:
 Battery Charge Current: Battery Code: Float Current:
 Charging Equipment: Ambient Temperature: Cell Temperature:

Battery Charger Information

Make Type Current rating
 Model Year of manufacture Charging voltage

INDIVIDUAL CELL READINGS

Cell No.	Float Volts	Test Volts	Cell No.	Float Volts	Test Volts	Cell No.	Float Volts	Test Volts	Cell No.	Float Volts	Test Volts	Cell No.	Float Volts	Test Volts
1			26			51			76			101		
2			27			52			77			102		
3			28			53			78			103		
4			29			54			79			104		
5			30			55			80			105		
6			31			56			81			106		
7			32			57			82			107		
8			33			58			83			108		
9			34			59			84			109		
10			35			60			85			110		
11			36			61			86			111		
12			37			62			87			112		
13			38			63			88			113		
14			39			64			89			114		
15			40			65			90			115		
16			41			66			91			116		
17			42			67			92			117		
18			43			68			93			118		
19			44			69			94			119		
20			45			70			95			120		
21			46			71			96			121		
22			47			72			97			122		
23			48			73			98			123		
24			49			74			99			124		
25			50			75			100			125		

Remarks and Recommendations: _____



Signed: _____

