Maintenance of Saft Railroad NICAD® Batteries
Battery Maintenance Seminar
Saft Pocket Plate NICAD® Batteries

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Basic Safety Rules for Saft NICAD® Cells

1. Always wear eye protection when working on, near or around batteries.
2. Always touch ground post or attach ground strap prior to working on, near or around batteries.
3. Always ground tip of any watering device prior to use to discharge possible static build up. **Never use metal tipped watering device.**
   **Always use de-ionized or distilled water.**
4. Always use insulated tools when working on, near or around any batteries.
   Install connector covers.
5. Keep vent caps closed when working on, near or around batteries.
   Use of flame arrestor vent caps recommended on all cells.
6. Remove or open one vent cap at a time when watering cells.
7. Use water to clean cells and vent caps.
   **Do not use solvents, vinegar, lemon/lime cleaners or aerosol sprays**
8. Use anti-corrosive oil or grease to coat connectors and terminals.
9. A pocket plate NiCd cell will not consume any water until properly charged.
   Recommended setting for standard NiCd - ‘ED’ & SCM:
   1.45 – 1.47 vpc @ 68°F / 20°C
   Recommended setting for recombination SPL:
   1.43 – 1.45 vpc @ 68°F / 20°C
   Record all cell, battery bank, charger and AC input readings
10. A properly charged standard NiCd (ED/SCM) will consume approx. 1/16” to 1/8” of water per 30-day period.
    A properly charged ‘SPL’ recombination type NiCd will consume approx. 1/2 ” to 3/4 “ of water per 365-day period.
11. A properly charged standard pocket plate NiCd (ED-SCM) will have tiny bubbles present on the plates and on the surface of the 1/8” layer of cell oil on top of the electrolyte. **Use high-grade mineral oil, only.**
   **NOTE: Do Not Add Cell Oil to SPL Batteries. No Cell Oil Required**
13. 1mA charge per amp hour rating of cell is required to offset internal loss.
14. Review MSDS sheet provided by manufacturer.

**SAFETY FIRST - Murphy’s Law is always in effect.**
General

Saft pocket plate NICAD® railroad batteries require minimal maintenance and have a proven 25+ year record of reliability. These recommended maintenance procedures are designed for our railroad customers using batteries for rail signal and communication applications. No special tools are required except a voltmeter, and no test facilities or maintenance shops are needed to maintain batteries in first class operating condition. By participating in Saft's battery reconditioning program, battery life will be extended, life cycle cost will decrease and battery disposal problems will be eliminated.

Safety First

Before anyone starts working with batteries, this safety information must be studied carefully. Because of their low voltage and harmless appearance, batteries are often treated without due respect and caution, sometimes with tragic results. Battery related accidents can easily be avoided by awareness and understanding of the hazards involved and by handling the batteries accordingly.

There are three sources of potential hazards:

1. Corrosive electrolyte
2. Electric power
3. Explosive gasses

These are not only related to nickel cadmium batteries but apply to all types of industrial batteries, both wet types as well as the so-called sealed or maintenance free types. We will briefly discuss each of the hazard elements and how to avoid problems.

1. Corrosive Electrolyte

The liquid electrolyte is about 20% potassium hydroxide dissolved in water. This is a relatively strong corrosive solution that may burn skin and damage clothing. It is extremely hazardous to eyes or if swallowed and may, if such contacts occur, cause permanent damage! Skin contact will generally only cause minor irritations providing it is washed off quickly. The following protective measures are recommended:

Always wear eye protection when working with, around or near batteries. If you get electrolyte in your eyes, flush generously with clean water for at least 15 minutes, and seek medical attention as soon as possible.
Maintenance of SAFT NICAD® Batteries
For Railroad Applications

Never leave electrolyte in ordinary bottles, jars, cups, etc. Someone may drink it. This has actually happened.

Recommendations
Avoid storing electrolyte, if possible; if you must, only use properly marked containers with appropriate warning labels. Keep it out of reach of children and unauthorized persons.

For skin protection, wear rubber gloves, long sleeves and a face shield.

For protection of clothing, wear rubber or plastic aprons or other appropriate protection.

Make sure all vent caps are properly closed while moving or transporting cells or batteries. When watering, make sure to only remove or open vent cap on cell to be watered.

Always keep water readily available for rinsing and washing.

2. Electrical Hazards

Both voltage and current must be handled with caution. Electric potential under 50 volts is rarely fatal, and the 12 volt batteries generally used in signaling application do not on their own represent any danger in the form of electric shocks. However, in other applications batteries are often connected in series to provide voltages of 50 volts and more. Such batteries must be treated with due caution to avoid exposure to dangerous voltage. Also, do not disregard the possibilities for electrical faults in chargers or converters that may apply a dangerously high voltage even to a 12 volt battery. Railroad batteries are capable of delivering short circuit currents of several thousand of amperes. Therefore, be extremely careful with metal objects near these batteries:

- Do not wear rings, watches, bracelets, etc. when you work on batteries.
- Use only tools with insulated handles.
- Do not place any metal objects on the top of the battery.
- Keep intercell connector covers in place at all times.
- Avoid removing or replacing battery connections or intercell connectors with high charging current or with load connected.
3. Battery Gasses

During charging, hydrogen and oxygen will be produced. Hydrogen is an explosive gas when mixed with oxygen or air, unless highly diluted by air. We must, therefore, always take precautions to avoid the risk of an explosion.

Never smoke or use an open flame near a battery.

Caution should be taken to discharge static electricity when working on, near, or around batteries.

- External explosions

   Hydrogen gas may accumulate in the battery enclosure, particularly if there is poor ventilation. Before starting work on a battery, open enclosure doors and give the gasses some time to escape. Hydrogen gas is lighter than air and will accumulate in the top of enclosures.

   If the battery has been on high rate charge or has recently been gassing heavily, give more time to ventilate before removing any cables or connectors. Never do such work if the charger is still in a high rate charging mode. Never remove intercell connectors if you expect that battery gasses may still be present.

- Internal Explosions

   Gasses inside a cell should always be treated as highly explosive. Always use vent caps equipped with flame arrestors and always keep these vents closed, when removing connectors or working with conductive tools around the battery. Internal cell explosions will rupture cell cases and cause electrolyte spray.

For additional safety, make sure the batteries and associated equipment are installed in full compliance with current AAR instructions and that the manufacturer’s recommendations, as well as the National Electrical Safety Code, have been observed. Use only approved equipment and materials.

Study the Installation and Maintenance Instruction, as well as the Material Safety Data Sheet supplied with the batteries. Keep these available at each battery location.
The batteries are equipped with safety features such as flame arresting vent caps and insulating covers for the intercell connectors. Make sure those items are always in place and replaced immediately if broken or lost. Some of the older batteries may not be equipped with flame arresting vent caps. These older vent caps must be replaced immediately.
Single cells Ni-Cd range
Type SCL, SCM, SCH, plastic case
Installation and operating instructions

Important recommendations

- Never allow an exposed flame or spark near the cells, 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 when working on the battery.
- Use tools with insulated handles.
- Avoid static electricity and take measures for protection against electrostatic shocks.
- Discharge any residual static electricity on clothing and/or tools by touching an earth connected part before working on the battery.

1. Receiving the shipment

Unpack the battery immediately upon arrival. Do not overturn the package. Transport seals are located under the cover of the vent plug.
- The battery is normally shipped discharged and empty. Do not remove the plastic transport seals until ready to fill the battery.
- If the battery is shipped filled and charged, the battery is ready for installation. Remove the plastic transport seals only before use.
- The battery must never be charged with the transport seals in place as this can cause permanent damage.

2. Storage

Store the battery indoors in a dry, clean, cool (10°C to 30°C) and well-ventilated space on open shelves.
- Do not store in unopened packing cases. The lid and the packing material on top of the cells must be removed.
- Make sure that the transport seals remain in place during storage.
- Do not store in direct sunlight or expose to excessive heat.

- Cells empty and discharged:
  - SAFT recommends to store cells empty and discharged. This ensures compliance with IEC 60 023 section 4.9 (storage).
  - Cells can be stored like this for many years.

- Cells filled and charged:
  - If cells are stored filled, they must be fully charged prior to storage.
  - Cells may be stored filled and charged for a period not exceeding 12 months from date of dispatch.
  - Storage of a filled battery at temperatures above 30°C can result in loss of capacity. This can be as much as 5% per 10°C above 30°C per year.

3. Installation

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.

3.2. Ventilation

During the last part of charging, the battery is venting gases (oxygen and hydrogen). 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.

3.3. Mounting

Verify that cells are correctly interconnected with the appropriate polarity. The battery connection lead should be with nickel plated cable lugs.

Recommended torques for connecting nuts are:
- M6 = 5 ± 0.5 Nm
- M10 = 16 ± 2 Nm
- M20 = 70 ± 7 Nm

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

Remove the transport seals and close the vent plugs.

3.4. Electrolyte / cell oil

- Cells delivered filled and charged:
  - Check the level of electrolyte. It should not be more than 20 mm below the upper level mark. If this is not the case, adjust the level with distilled or deionized water.
  - Cells delivered filled have already the cell oil in place.

- Cells delivered empty and discharged:
  - If the electrolyte is supplied dry, prepare it according to its separate instructions sheet. The electrolyte to be used is E29. Remove the transport seals (just before filling).

Fill the cells about 20 mm above the lower level mark with electrolyte. Wait 4 to 24 hours and adjust if necessary before commissioning.

It is recommended to add the cell oil after the commissioning charge, with the syringe, according to the quantity indicated in the table A.

4. Commissioning

Verify that the ventilation is adequate during this operation.

A good commissioning is important.

Charge at constant current is preferable.

When the charger maximum voltage setting is too low to supply constant current charging, divide the battery into two parts to be charged individually.

If the current limit is lower than indicated in the table A, charge proportionally for a longer time.

- For cells filled on location or for filled cells which have been stored more than 6 months:
  - Charge 10 h at 0.2 CA (recommended)
  - or charge for 30 h at 1.65 V/cell, current limited to 0.2 CA
  - or charge at 0.2 CA to 3.0 V/cell
  - charge according to the section below.

- For cells filled and charged by the factory and stored less than 6 months:
  - Charge 10 h at 0.2 CA (recommended)
  - or charge 24 h at 1.65 V/cell, current limited to 0.2 CA
  - or charge 48 h at 1.55 V/cell, current limited to 0.2 CA

- Cell oil & electrolyte after commissioning:
  - Wait for 4 hours after commissioning.
  - Cells delivered filled by the factory have already the cell oil in place.
  - For cells filled on location, add the cell oil with the syringe, according to the quantity indicated in the table A.
  - Check the electrolyte level and adjust it to the upper level mark by adding:
    - distilled or deionized water for cells filled by the factory
    - electrolyte for cells filled on location.

The battery is ready for service.
5. Charging in service
- Continuous parallel operation, with occasional battery discharge.
  Recommended charging voltage (+20°C)
  to 25°C:
  For two level charge:
  - Lead level: 1.47 ± 0.01 V/cell for SCL
  - High level: 1.45 - 1.70 V/cell for SCL.
  A high voltage will increase the speed and efficiency of the charging.
- Single level charge: 1.43 - 1.50 V/cell.
- Buffer operation, where the load exceeds the charger rating.
  Recommended charging voltage (+20°C)
  to 25°C: 1.50 - 1.60 V/cell.

6. Periodic Maintenance
- Keep the battery clean using only water.
  Do not use a wire brush or solvents of any kind.
- Check the electrolyte level.
  Never let the level fall below the lower mark.
  Use only distilled or de-ionized water to top-up.
  Experience will tell the time interval between topping-up.
- Note: Once the battery has been filled with the correct electrolyte either at the
  battery factory or during the battery commissioning, 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 connectors are tight.
- Check the charging voltage. In parallel operation, it is of great importance that
  the recommended charging voltage remains unchanged.
- High water consumption of the battery is usually caused by improper voltage
  setting of the charger.

7. Changing electrolyte
- In most stationary battery applications, the electrolyte will retain its effectiveness
  for the life of the battery. However, under special battery operating conditions, if the
  electrolyte is found to be carbonated, the battery performance can be restored by
  replacing the electrolyte.
- The electrolyte type to be used for replacement in these cells is: E13.
  Refer to "Electrolyte instructions".

8. Environment
- To protect the environment all used batteries must be recycled.
- Contact your local representative for further information.

Table A:

<table>
<thead>
<tr>
<th>Cell type</th>
<th>Charge rate (A)</th>
<th>Charge voltage (V)</th>
<th>Terminal per</th>
<th>Cell</th>
<th>Charge rate (A)</th>
<th>Charge voltage (V)</th>
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</thead>
<tbody>
<tr>
<td>GNB 180</td>
<td>2.45</td>
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<td>2.45</td>
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</tr>
<tr>
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<td>4.2</td>
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<tr>
<td>GNB 260</td>
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<tr>
<td>GNB 280</td>
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<tr>
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<td>GNB 320</td>
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<tr>
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<td>15</td>
<td>GNB 340</td>
<td>4.05</td>
<td>4</td>
</tr>
</tbody>
</table>

* Value for initial rating (E122)
The cell type shown the rated capacity in ampere hour (Ah)

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Page 7
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ED range
Nickel-Cadmium batteries
Installation and operating instructions

Important recommendations

Never smoke or allow an open flame near the battery. The electrolyte is corrosive. In the event of contact with skin or eyes, wash immediately with running water. If eyes are affected, flood with water and obtain immediate medical care. Wear goggles, gloves and an apron or protective clothing when handling electrolyte and cells. Use tools with insulated handles and always remove jewelry, watches and any clothing with metal parts when working with batteries. Never use sulphuric acid or acidified water (pH lower than 5) for topping-up, since even traces of acid may destroy the battery.

1. Receiving the shipment
Unpack the battery immediately upon arrival. Do not overturn the package.
- If the battery is shipped filled and will be used immediately, remove the plastic transport seals. The battery is then ready for installation.
- If the battery is shipped discharged and empty, do not remove the plastic transport seals until ready to fill the battery.
- Transport seals must be removed before charging to prevent permanent damage and/or explosion.

2. Storage
Store the battery indoors in a dry and clean location. Avoid direct sunlight or fluorescent light.
- ED batteries are normally delivered filled with electrolyte and charged. They can be stored this way for a maximum of 1 year.
- ED batteries that are discharged and empty can be stored for many years.
- If cells are stored, make sure that the vent caps are correctly closed and the transport seals are securely in place. Refer to Section 4 for proper commissioning after storage.

3. Installation
Remove transport seals and close vent caps.

3.1. Verify that the cells are correctly interconnected and that battery connection to the load is also correct.

3.2. Check tightness of terminal connecting nuts and cap screws (if supplied). Torque applied shall be:
- Top Terminal Nut (15/16") 37 + 3 ft. lb. (50 + 3 N.m) (5/8" post).
- Cap Screw (1/2") 15 + 2 ft. lb. (20 + 2 N.m) (5/16" stud).

The connectors, terminals, nuts, and cap screws (if supplied) should be corrosion-protected by a thin layer of Saft anti-corrosion coating or neutral vaseline.

3.3. Electrolyte
The electrolyte to be used is: E13 or E12 for low temperatures.

Cells delivered filled:
Check the level of electrolyte. Cells must have an electrolyte level above the plates. If they do not, adjust the level of electrolyte to 3/16" (5 mm) above the plate tops with distilled or deionized water. Cells delivered filled already have the cell oil in place.

Cells delivered empty:
Fill empty cells to 3/16" (5 mm) above the plate tops with electrolyte. Add cell oil by syringe per Table A.

4. Commissioning

4.1. Filled cells stored less than 1 year:
- Constant current charge:
  - 15 hours at 0.2 C, A.
- Constant potential charge:
  - 1.65 V/cell for 20 - 30 hours, with the current limited to 0.2 C, A.
Charge at constant current is preferable.

4.2. Cells which have been filled from discharged and empty:
- Charge 15 hours at 0.2 C, A.
- Discharge at 0.2 C, A down to 0.8 V/cell or less.
- Charge 10 hours at 0.2 C, A.
- Wait at least 4 hours after the end of the charge and adjust the electrolyte level to the high level mark by adding electrolyte. If constant current charge is not possible, charge at 1.65 V/cell for 20 - 30 hours with the current limited to 0.2 C, A.

4.3 The battery can be connected to the load following steps 4.1 or 4.2 and 7. Refer to Table A for 0.2 C, A charging currents for the various cell types.

5. Charging in service

5.1. Buffer applications
The battery is cycled from 5 to 20% depth of discharge (DOD) per day.
- Single level charge (at battery terminals):
  - 1.50 - 1.60 V/cell at +68°F (+20°C).
- Two level charge (at battery terminals):
  - High level: 1.55 - 1.65 V/cell at +68°F (+20°C).
  - Float level: 1.40 - 1.42 V/cell at +68°F (+20°C).
5.2. Floating and emergency applications

Battery is on float and discharged only in an emergency situation.

- Single level charge (at battery terminals):
  - 1.45 - 1.55 Vccell at +68°F (+20°C).
- Two level charge (at battery terminals):
  - High level: 1.50 - 1.65 Vccell at +68°F (+20°C).
  - Float level: 1.40 - 1.42 Vccell at +68°F (+20°C).

For use at temperatures outside +60°F to 85°F (+10°C to +30°C), the charge voltage correction factor (temperature compensation) is:

- +2mV/C°cell if charging voltage is <1.85 Vccell at +68°F (+20°C).
- +3mV/C°cell for charging voltage between 1.45 and 1.65 Vccell at +68°F (+20°C).

For higher charging voltages, consult Saft. To minimize the water usage, Saft recommends the use of low charging voltages. Consult Saft for recommended charging currents.

6. Topping-up

- No electrolyte level measurement is necessary if a Saft filling pistol (Celltopper) is used. Simply fit the correct spacer to tube #, and probe length.
- If a filling pistol is not available, a clean plastic filling bottle can be used for topping-up. Do not fill above the high level mark. All topping-up equipment shall be dedicated to Saft NiCd® batteries.

7. Periodic maintenance

Periodic maintenance should be carried out once a year, or as required.

- Keep the battery clean using only water. Do not use a wire brush or solvents of any kind. Vents can be rinsed in clean water if necessary.
- Check the electrolyte levels. Never let the levels fall below the low level mark. Use only distilled or deionized water for topping-up. Frequency of topping-up must be determined for each battery. It depends on charging voltage, temperature and actual utilization of the battery.

<table>
<thead>
<tr>
<th>Table A</th>
<th>Cell Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell type</td>
<td>Rated capacity C2Ah (Ah)</td>
</tr>
<tr>
<td>ED 80 (LT/F)</td>
<td>80</td>
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<tr>
<td>ED 120 (LT/F)</td>
<td>120</td>
</tr>
<tr>
<td>ED 160 (LT/F)</td>
<td>160</td>
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<tr>
<td>ED 240 (LT/F)</td>
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<td>340</td>
</tr>
<tr>
<td>ED 400 (LT/F)</td>
<td>400</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table B</th>
<th>Topping-up equipment (Celltopper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell type</td>
<td>Probe diameter (mm)</td>
</tr>
<tr>
<td>ED 80</td>
<td>11</td>
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<td>ED 120</td>
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<td>ED 340</td>
<td>11</td>
</tr>
<tr>
<td>ED 400</td>
<td>11</td>
</tr>
</tbody>
</table>

- Check torque of upper nuts and cap screws (if supplied).
- Apply a thin layer of Saft anti-corrosion coating, or neutral vaseline, to all connectors, terminal nuts and cap screws (if supplied).
- Check charger settings. It is of great importance that the recommended charging voltage remains unchanged. High water consumption of the battery is usually caused by improper voltage setting of the charger.

8. Changing electrolyte

In most battery applications, the electrolyte will retain its effectiveness for the life of the battery. However, under special battery operating conditions, if the electrolyte is found to be carbonized, the battery’s performance can be restored by replacing the electrolyte. (Refer to Electrolyte Instructions.) The replacement electrolyte is:

ED: E13, EDLT: E12.

9. Battery service and recycling

Contact your Saft representative concerning battery testing. Saft America Inc. is licensed to recycle spent batteries. All nickel and cadmium plates are recycled.

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DOC. N° 03.01-xxxx-2.1

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SPL Ni-Cd batteries

Installation and operating instructions

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.

1. Receiving the shipment

Unpack the battery immediately upon arrival. 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. Transport seals are located under the lid of each can, they must be removed prior to mounting. The battery must never be charged with the plastic transport seals in place as this is dangerous and can cause permanent damage.

2. Storage

Store the battery indoors in a dry, clean, cool location (0°C to -30°C / +32°F to -67°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 -35°C (+3°F) per year. Do not store in direct sunlight or expose to excessive heat. SPL batteries are supplied filled with electrolyte and charged. They can be stored in this condition for maximum 12 months. Never drain the electrolyte from the cells.

- When the batteries are made in cardboard boxes, store without opening the boxes.
- When the batteries are made in plywood boxes, open the boxes before the storage. The lid and the packing material on top of the cells must be removed.

3. Installation

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).

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.

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 torque for terminal bolts: 30 + 3 N.m (22 + 2 ft-lb). The connectors and terminals should be corrosion-protected by coating with a thin layer of anti-corrosion oil. Remove the transport seals and close the vent plugs.

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. The level should be at least 15 mm (5/8") above the minimum level mark and there is normally no need to adjust it. Do not topup levels prior to initial charge.

4. Commissioning

Verify that the ventilation is adequate during this operation.

4.1. Cells stored up to 6 months.

A commissioning charge is normally not required and the cells are ready for immediate use. If full performance is necessary immediately, a commissioning charge as mentioned in section 4.2 is recommended.

4.2. Cells stored more than 6 months and up to 1 year.

A commissioning charge is necessary:
- Constant current charge: 16 h at 0.1 C A maximum (see the current in Table A)
- Constant potential charge: 1.65 V/cell for a maximum of 30 h with current limited to 0.1 C, A (see the current in Table A). If these methods are not available, then charging may be carried out at lower voltages, 1.50 V/cell for 72 hours minimum.

5. Charging in service

The recommended charging voltages for continuous parallel operation, with occasional battery discharges, are
- for two level charge:
  - float level: 1.42 ± 0.01 V/cell
  - high level: 1.45 ± 0.05 V/cell
- for single level charge: 1.43 ± 0.02 V/cell

The maximum charge voltage can be increased up to 1.50 V/cell when the temperature compensation is not available for low temperatures or when the battery is deep discharged several times a month.

For use at temperatures outside the range of +15°C to +25°C (+59°F to +77°F), a temperature compensation is recommended to further optimize the topping-up intervals at high temperatures. The recommended value is 3 mV/°C/cell (+1.7 mV/°F/cell).
SPL Ni-Cd batteries

6. Periodic Maintenance
SPL is an ultra low maintenance battery and requires the minimum of 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. Vent plugs can be rinsed in clean water if necessary.**

- **Check visually the electrolyte level.** Never let the level fall below the maximum level mark. Use only distilled or deionised water to top-up. Experience will tell the time interval between topping-up.

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

- **Check the charging voltage. It is important that the recommended charging voltage remains unchanged.** The charging voltage should be checked at least once yearly. High water consumption of the battery is usually caused by improper voltage setting of the charger.

  **Caution:** cell oil shall not be used.

7. Environment
To protect the environment all used batteries must be recycled.
Contact your local Saft representative for further information.
Visual Inspection of NiCd Storage Batteries in Service

1. Excessive Salts, Cause and Effect
   - Overcharging of battery. Check battery charger voltage and current settings.
   - The battery bank may contain one or more defective or shorted cells, causing remaining good cells to overcharge. Check all individual cell voltages; voltage of each cell should be almost identical.
   - Insufficient amount of battery oil floating on top of electrolyte, approximately 1/8”. Battery oil is high grade mineral oil. **Recombination SPL NiCd cells do not require cell oil.**
   - Excessive salts around battery posts. Possible defective seal around battery posts. Check plastic positive or negative pole nut washers for possible cracks and insure that bottom pole nut, on ‘ED’ cell is properly torqued, to approx 12 ft lbs.
   - Excessive salts around seams. Check for seam leaks around joint where top and case are joined. Leakage can be corrected by washing off seam with damp cloth, drying thoroughly and applying thin bead of epoxy along the length of the seam.
   - Excessive salts around vent caps. Check existing vent cap washer for deterioration. The proper vent cap for all flooded storage batteries is a flame arrestor type vent cap. The newer Saft flame arrestor vent cap complies with all Safety and OSHA rules governing flame arrestor caps for flooded storage cells. This newly developed cap will reduce the buildup of excessive salts and aid in the reduction of watering required for properly charged cells.

2. Proper Height and Color Appearance of Electrolyte
   - Brownish or copper color of electrolyte. Possibly caused by burst negative plate. Voltage of this cell will be high and capacity very low. Replace cell immediately.
   - Inky black electrolyte color may indicate shorted cell. Voltage of this cell will be low. Replace cell immediately.
   - Excessive black sediment inside jar and in the solution. This could be the result of severe overcharging of battery and extremely low electrolyte level. The sediment is probably graphite, which is released from inside the pocket plates when the solution level falls below the minimum reservoir line.
   - Note and record actual solution height from the maximum reservoir line. A properly charged standard pocket plate NiCd battery will consume 1/16” to 1/8” of water per each 30-day period. We recommend deionized or distilled water be added if solution levels are midway between the top and bottom reservoir lines. Remember, a battery will only consume water once it is fully charged.
## TEMPERATURE/VOLTAGE VARIATION TABLE

<table>
<thead>
<tr>
<th>Solution Temp. °F</th>
<th>Solution Temp. °C</th>
<th>Voltage Per Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>43.3</td>
<td>1.37</td>
</tr>
<tr>
<td>100</td>
<td>37.75</td>
<td>1.39</td>
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<tr>
<td>90</td>
<td>32.2</td>
<td>1.41</td>
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<tr>
<td>80</td>
<td>26.5</td>
<td>1.43</td>
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<tr>
<td>68</td>
<td>20</td>
<td>1.45</td>
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<td>60</td>
<td>15.5</td>
<td>1.47</td>
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<td>50</td>
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<td>40</td>
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<td>1.59</td>
</tr>
<tr>
<td>-10</td>
<td>-23.3</td>
<td>1.61</td>
</tr>
</tbody>
</table>

**Notes:**
- Two mV change per degree from 68°F.
- Voltage per cell based on fully charged cell.

### Date Codes

SPL/ SCM date code on sticker, listed as
‘Code 0501” = January 2005

‘ED’ date code hot stamped on top of cell,
9 digits – 1st two digits - month, 2nd two digits - year
0799XXXXXX – July 1999
Maintenance of SAFT NICAD® Batteries
For Railroad Applications

Installation

As proper installation is a requirement for using these maintenance recommendations, it is necessary to point out some installation requirements:

- **Housing** – The batteries should be installed in well ventilated cabinets or enclosures offering full protection from rain and direct sun. As far as possible, they should also be protected from dust and dirt accumulation and elevated temperatures. The standard AAR relay cabinets and bungalows are quite suitable for this purpose.

- **Easy Inspection** – The batteries should be installed in a well-lit position suitable for each inspection. It must be possible to observe electrolyte levels as well as gassing activities through the clear cell jars of each cell.

- **Easy Top-Up** – There must be enough space over the top of the cells for easy watering.

- **Electrical Connections** – All intercell connections and cable connections must be properly torqued.

- **Corrosion Protection** – All metal parts should be coated with Saft NOX-Rust protective coating.

Charging Equipment

Many different types of chargers are available. As some types will provide for reduced maintenance, improved state of charge and longer battery life, we need to take a very brief look at the most common types. Basically, constant voltage, single or two rate chargers are commonly utilized. Saft pocket plate NiCd batteries are very tolerant to variations in charging conditions and will provide safe and reliable service even when very simple chargers with relatively poor voltage regulation are used.

Single rate chargers, without an automatic high rate, should be set at a relatively high float voltage of about 1.45 volts per cell at 68°F/20°C. Make sure the charger is capable of handling the location’s AC line voltage variations without too much variation in charging voltage. High charging voltages (1.50+ volts per cell) may dramatically increase the water consumption. Low charging voltages (1.40 or less volts per cell) will decrease battery capacity capability.
The advantage of single rate chargers is that they are inexpensive, simple and reliable. The 1.47 to 1.45 volts per cell, at 68°F / 20°C, is a compromise charging level that will give acceptable results both from a recharging point of view as well as from a water consumption point of view without compromising safe and reliable operation of the nickel cadmium battery.

Dual rate battery chargers will quickly re-charge the batteries after a discharge in a high rate mode (1.55 – 1.70 volts per cell), and should automatically change to a float voltage (1.42 vpc) as soon as the batteries are fully charged. This will ensure that the batteries are normally operated at close to 100% state of charge, which will extend the battery life and provide full battery capacity. In addition, the lower float voltage will reduce water consumption considerably.

Temperature compensated charges will give some added benefits but are not required for nickel cadmium batteries except in extreme temperature variations. The main disadvantage with dual rate and temperature compensated chargers is higher costs. There may also be a restriction on high battery voltage, limiting the possibility of using the high rate charging effectively.

Refer to the Installation and Operating Instructions for complete charging instructions.

**Regular Maintenance**

Battery maintenance should fit in with other equipment inspection and maintenance. There is no need to introduce special inspections and maintenance schedules for the batteries. Under any circumstances, do not leave the batteries unattended for more than six months. During inspections, the following should be checked:

1. Physical condition
2. Electrolyte levels
3. Charging voltage
4. Dirt accumulation

When the battery is normal and healthy, this should not take more than a couple of minutes. If watering is required, this should take less than five minutes for a nine to ten cell battery. If regular battery inspections including normal maintenance take more than ten minutes, the battery installation should be examined and corrective action should be taken. The following is a checklist for what to look for and what action to take with healthy as well as suspect batteries.
Normal Battery Conditions

1. Physical Condition – Check that all cells are dry on the outside and that there are no signs of electrolyte seepage. Carry out this check before cells are topped up with water.

   Check that vent caps, intercell connectors and cables and connector covers are in place and in good condition.

2. Electrolyte Levels – Observe and record (if required by your SOP) electrolyte level for each cell. Small variations in electrolyte levels are normal. If any cell has lost more than ½ of its reserve, top-up all cells evenly to the “max” level mark with distilled or de-ionized water. A properly charged standard pocket plate NiCd cell will consume 1/16” to 1/8” water per 30 day period.

   Never use sulfuric acid or any containers, vessels, or tools contaminated by acid.

3. Charging Voltage – The battery is presumed to be fully charged and the charger is in the float charging mode. Check overall charging voltage. The charger should be no more than 1% from its correct float charging level.

   Check individual cell voltages. Record (if required by your SOP). The cell voltages should be quite even and must not deviate more than ±.02 volts (20mV) from the average cell voltage.

   In lieu of voltage readings, a visual inspection for gassing activities may be performed. It will require experience and good eyesight to make a meaningful observation. On float charge, the gassing should be minimal but even in all cells. Tiny bubbles should be present on the plate surface as well as in the 1/8” layer of oil floating on top of the electrolyte.

4. Dirt Accumulation – The battery should be relatively clean and dry with no more dust accumulation than other equipment in the same enclosure. Wipe off with a damp cloth. Excessive accumulation of salts (dried KOH) on cell top could be an indication of overcharging, an insufficient amount of oil on top of electrolyte, or cracked or damaged vent caps, washers and seals.
Abnormal Conditions and Corrective Action

The following recommendations are general and may need to be modified and tailored to conform to the Standard Operation Procedure (SOP) for each railroad.

1. Physical Condition

Cells found to be leaking from cracks in the jar below the minimum electrolyte level mark must be taken out of service immediately. Follow procedures as described under “Repairs On Site”.

Leaks around the cell lid, posts, and vents are less serious, but such cells will eventually have to be replaced, particularly if the leaks are causing extra maintenance work. Such cracks may also represent a safety hazard as battery gasses may bypass the flame arrestor vent. Take extra precaution against ignition from sparks, etc.

Leaks through minor defects in the top of the cell may not necessarily show up as wet electrolyte. Accumulation of a gray/white salt (potassium carbonate) is more often the result. Electrolyte has a much stronger ability to travel up walls and penetrate openings than most other liquids. Small quantities of electrolyte will, after escaping to the outside of the cell, dry up and react with carbon dioxide from the air and form potassium carbonate. This is a relatively harmless salt that will easily dissolve in water and can therefore be removed by a wet rag.

If the accumulation of salt causes extra maintenance work, the cell should be thoroughly inspected and replaced if needed. Note: Small traces of salt are normal and will always appear after long periods. This should be removed as part of the normal cleaning.

Broken or missing vent caps must be replaced as soon as possible as open vents increase the risk of possible cell explosion. Older vent caps without flame arrestors should also be replaced.

Badly corroded nuts, bolts, intercell connectors, lugs, or cables must be replaced. Corrosion is a sign of insufficient corrosion protection and/or improper installation and maintenance. Make sure all metal parts are protected by Saft NOX-Rust.

Replace broken or missing connector covers.
Maintenance of SAFT NICAD® Batteries
For Railroad Applications

Properly torque connections normally do not need re-torquing. It is, however, good practice to check a newly installed battery or an old battery if it has been subjected to extreme temperature variations. Torque values are listed on the "ED Installation and Maintenance Instructions".

2. Electrolyte Levels

Abnormal water consumption is a sure sign that something is wrong and that further investigation is needed. A properly charged/floated battery will consume between 1/16” and 1/8” of water per 30 day period. Here are some situations that may be encountered:

2.1 No water has been consumed for more than three months. The overall charging voltage is probably too low. Check carefully, and adjust as necessary. If the charging voltages were correct, there must be a loose connection in the battery circuit. Check all cables and intercell connectors carefully. Check water consumption again after more than three months.

2.2 The battery has used a lot of water. Check when the last top-up occurred. Take ambient temperature during that period in consideration. Remember, a 20°F increase in temperature will more than double the water consumption. If the water consumption still appears excessive, the charging voltage must be too high. Check and adjust.

If the charger is equipped with a high rate stage, check if this is working properly or is being used properly.

2.3 The various cells show great variation in water consumption. Remember that water consumption in a fully charged battery is directly related to the charging current. The same current should normally pass through all cells and cause even water consumption. Any abnormalities, such as internal or external short circuits of a cell, would provide a bypass route for the current, and that particular cell would not consume any water. While a complete short circuit would eliminate water usage completely, a resistive circuit would reduce the usage. Such conditions could occur from accumulation of dirt on the battery or fault conditions inside cells.

Cells affected in this manner would normally display low cell voltage. See section three below.
Batteries that are often discharged and recharged will have more uneven water consumption than batteries on permanent float charge. The reason is that on recharge some cells will reach full charge before others and start gassing earlier. These cells will naturally lose the most water.

2.4 Always record the amount of water added to cells, i.e. ½", ¼", etc.

In conclusion, when uneven water consumption is observed, make sure the battery is clean and check the cell voltages carefully. There is always a reason.

3. Battery Voltage

While Saft pocket plate NiCd batteries are very tolerant to variation in the charging voltage, correct charging voltage is important for efficient and cost effective maintenance. Water consumption will double with only a 3% increase in charging voltage. If the charging voltage is too low, the battery may not be fully charged.

If any individual cell voltage varies more than ±0.02V (20mV) from the average cell voltage, some action should be taken. Generally, it is cells with low voltage that are causing the problem. Several cells with low voltage may force other cell voltages to go high. If low cell voltages cannot be improved by cleaning or high rate charging, such cells should be replaced. If a single cell is found with high voltage, check the cell connections.

4. Dirt Accumulation

As we have learned above, dirty cells may divert the charging current and cause uneven charging as well as uneven water consumption. It is therefore important to keep the battery clean. If there is heavy dust or dirt accumulation that cannot easily be removed during normal cleaning or if the dirt often interferes with normal charging, some positive action should be taken to improve the situation. It may be necessary to make modification to the enclosure to improve dust protection.

Providing proper housing for batteries is a good investment. A clean environment for batteries and other equipment will reduce maintenance costs and make all equipment more reliable and durable.
**Maintenance Tools**

As the only regular maintenance consists of watering, voltage readings and cleaning, the only required equipment is a water bottle, a voltmeter, and a wet rag. In its simplest form, the water bottle can be a hand-held plastic squeeze bottle. An additional plastic storage can is recommended. More elaborate top-up equipment is available, such as larger pump-up pressurized bottles and electric pumps connected to filler guns. Such equipment is normally not required for a nine or ten cell signaling battery.

**Voltmeter** must be able to measure the overall battery voltage with a 0.5% accuracy and measure cell voltages down to $\frac{1}{100}$ of a volt. A **hydrometer** may be used to check the specific gravity (SG) of the electrolyte. Proper SG will guard cells against freezing and provide optimum battery capacity. Hydrometer tests are suggested on older cells (10-15 years) and can be performed at intervals of 5-10 years. The normal loss of SG is $\frac{1}{2}$ to 1 point per year on properly charged cells.

**Battery Testing**

Providing our maintenance recommendations are followed, regular battery testing is not necessary as with other types of batteries. It is, however, good practice to test older batteries periodically as well as batteries on sites with high loads and marginal battery capacity. The following simple test may be carried out to verify battery performance.

Check and record cell voltages with AC power applied (per Railroad SOP).

Switch the battery charger off. Check that the battery voltage is maintained well over critical minimum levels. If not, stop the test and turn the charger back on. The battery should be inspected closely.

If the battery voltage is healthy, continue the test by applying operating loads. This may be achieved at a crossing by simulating a few normal gate operating cycles. Keep the battery voltage under observation. If the overall voltage drops close to the minimum level, check individual cell voltages. Any cell with extra low voltage (under 1.00 volt) should be marked for possible replacement. Terminate the test.

If the battery voltage remains well over the minimum level, continue the test for 10 to 15 minutes. At the end of the test, with the load connected and the charger still off, check individual cell voltages as above. All individual cell voltages of the battery should be on the same voltage plane. If the cell voltages vary more than .020 volts after this short discharge test, the charger settings should be raised 0.5 volt. The battery should be on this elevated charge rate for 24 hours. After this charging cycle, visually inspect each cell for excessive gassing. Each cell should display “a thousand tiny bubbles” floating on the 1/8 inch layer of oil in each cell. If, after this 24 hour cycle, all cells are not gassing then continue this elevated charging for an additional 24 hours. **CAUTION:** Make sure each cell has its solution at the maximum line before leaving the battery. After the second elevated charging period, cells that continue with extra low voltages should be marked for possible replacement.
Repairs On Site

On site repair generally means cell replacements. Bring the required cells or cell trays as well as proper tools. The replacement cells should be fully charged and topped up to the maximum level. Ventilate the enclosure well before working on the battery.

Disconnect the battery breaker or fuse. Loosen connectors or connecting cables for the cells or trays that need to be replaced. Remove cells or trays. Put new cells or trays into position. Make sure they are turned properly for correct cell polarity. Remember cells are connected in series by connecting negative to positive. Make sure all connections are properly torqued. Top off all cells to the maximum level. Reconnect the battery fuse or circuit breaker.

Cells leaking below the minimum level marks must be removed from service and replaced immediately. Apart from the risk of spilling a corrosive liquid, a drained cell on charge is always an explosion risk.

A missing cell must naturally be replaced as soon as possible and the charging voltage readjusted.

Other possible on site repairs are replacement of damaged and corroded intercell connectors, nuts, and bolts. Such repairs should not be necessary if the batteries are installed and maintained properly. Make sure all newly installed metal parts are coated with Saft NOX-Rust

Tools For Repairs

Insulated wrench, top-up bottle, voltmeter, and cleaning rags, no-rust oil or grease.
Transportation Of Batteries

New batteries should be transported in their original packing material. A leak-proof plastic or steel tote should be available for leaking cells. If leaking cells are being taken back to a depot for further transportation to Saft for test and repair, all leaked electrolyte should be poured into a separate plastic container for safe transportation. Make sure this container is properly labeled with appropriate warning labels. Saft’s service department has available on request printed packing and shipping instructions as well as warning labels.

**IMPORTANT:** Do not ship any material to Saft without a RMA (Return Material Authorization) number. Call: 229-245-2826.

A copy of the Saft Material Safety Data Sheet should accompany all cells in transit.

Repair and Return Program

Saft offers a simple and cost effective repair and return program. Older and suspect batteries and cells may be returned to Saft for test and evaluation. Any cells that cannot be restored to a predetermined capacity or performance will be disposed of through Saft’s recycling system.

Usable cells will be assembled into requested tray configurations, equipped with new hardware and electrolyte and shipped back to their owner for many more years of useful service.

Each railroad must decide in accordance with their own experience and convenience how often batteries need to be serviced in this manner. We would suggest that the frequency should be somewhere between 15 and 20 years. Ask Saft for a “repair and return” contract proposal.

This program eliminates the need for railroads to maintain and staff battery service shops and it also eliminates all battery disposal problems. It further eliminates the need for gravity readings and electrolyte changes.

Final Comments

Battery maintenance philosophy has changed significantly over the last few years. This is mainly a result of pressure on cost reduction in maintenance. Saft Nickel Cadmium Pocket Plate Batteries with their extremely stable chemistry are particularly suitable for simple and low cost maintenance without jeopardizing reliability, safety, and durability. As a matter of fact, they need less maintenance than so-called maintenance free batteries, and will at the same time provide a much higher degree of reliability, safety, and much longer life.

No special tools are needed and very little work is required to maintain the batteries in perfect working condition. As suspect cells are rare occurrences, we can afford to replace these rather than perform elaborate tests and repairs on site.

All in all, this maintenance program and the “repair and return” program offered by Saft combine to cut the railroads’ overall battery costs while still providing the most reliable battery back-up available in the market today.
Hazardous Materials
RETURN BATTERY PACKING INSTRUCTIONS
TEST/REPAIR & RETURN OF NICAD CELLS

1. Call 229-245-2918 to receive authorization (RMA#) to ship the batteries to Saft.

2. Discharge batteries if possible. Remove all cable or loose connectors that may cause cells to short or discharge.

3. Use pallets of uniform size with dimensions near 42 x 42 inches. The surface of the pallet must be flat without gaps to support the batteries. Add a plywood or other board surface if necessary.

4. Stand the batteries on a pallet with the vent caps installed and with shorter batteries surrounded by taller batteries.

5. Nail furring strips (1" x 2" or larger) around the outer edge of the batteries on the pallet.

6. Strap around the batteries. Place plywood or chipboard on top of the batteries.

7. Strap around the board and through the pallet in two directions to tie the batteries to the pallet. Two straps in each direction should secure the package.

8. Mark each pallet with RMA#__________________.

9. Mark each pallet in sequence with reference to the total number of pallets being shipped.
   Example: Pallet___ of____ pallets.

10. Mark with corrosive labels.

11. For repair and return, ship as hazardous material with the following description:
    Batteries, Wet, Filled with Alkali, 8, UN2795, PGIII

12. To dispose, scrap, or recycle, ship as Universal Waste with the following description:
    Used batteries, Wet, Filled with Alkali, 8, UN2795, PGIII

13. To dispose of Electrolyte liquid, ship as Hazardous Waste with the following description:
    Waste, Environmentally Hazardous Substance, Liquid, N.O.S., 9, UN3082, PGIII, (Potassium Hydroxide Solution).

14. Put RMA# on outside of all cartons, packing slips and Bill of Lading.

15. Ship to:  Saft America Inc.
        Attn: Reclamation Facility
        Dock  # 4
        711 Industrial Blvd.
        Valdosta, Ga. 31601
Proposed Repair And Return Program For ED/SCM Cells

1. Railroad will ship (amount to be determined) cells to our Valdosta, GA plant, under RMA number__________________________, covered by Purchase Order number_________________________. Cells will be run through our refurbishing program.

2. Work description at Saft plant:
   a) Unpack and inspect
   b) Dispose of broken cells (recycle)
   c) Clean, refill with electrolyte, if necessary, charge and discharge (C/5) test; test electrolyte (carbonate level, etc.)
   d) Dispose (recycle) cells with capacity under 65%
   e) Change electrolyte, charge and discharge (C/5) test, down to 1.0v per cell
   f) Dispose (recycle) cells with capacities under 80%
   g) At this point, a complete report on each cell going through the above steps, (a – f) will be sent to the originator of the RMA. The originator (Dist Sig Eng) will then advise us of the desired traying of returning cell per RMA. A copy of report, if required, will be sent to Regional Systems Signal Engineer.
   h) Reassemble acceptable cells into proper trays, per railroad customer's instructions. Replace all hardware with new, i.e. intercell connectors, bail type handles, flame arrestor flip top vent caps, and cell clip locks. Repair seam leakers, retorque nuts, clean, charge, apply protective coating, add oil, pack and repair for shipment. Each cell will be stamped with refurbishing date.

3. Suggestions

   Shipment of cells by the customer will be made in customer shipping totes; batteries returned to the customer will be in the same totes.

   Cells with manufacturing dates indicating an age of 15 years or older will be returned for refurbishing in full or near full totes.

   Tote shipments to SAFT will be made under the label “Material Being Returned To Manufacturer For Test And Evaluation”.

4. Total Cost Of Refurbishing

   Actual cost of refurbishing, including all test documentation, return shipping and disposal (recycling), will not exceed 33% of the cost of a new cell, cost based on each cell received at the SAFT facility in Valdosta, Georgia. The refurbished cells will be covered by a two year warranty.
MATERIAL SAFETY DATA SHEET

PRODUCT NAME: INDUSTRIAL POCKET PLATE
NICKEL-Cadmium Storage Battery

SAFT AMERICA Inc.
711 Gil Harbin Industrial Blvd.
Valdosta, GA 31601
Information: Phone 229-247-2331  Fax 229-245-2810

For Chemical Emergency
Spill, Leak, Fire, Exposure or Accident
Call CHEMTREC - Day or Night
800-424-9300

1. HEALTH HAZARD INFORMATION

Effects of Overexposure
Eye Effects: Contact with electrolyte solution inside battery causes very rapid, severe damage. Extremely corrosive to eye tissues. May result in permanent blindness.

Skin Effects: Contact with electrolyte solution inside battery may cause serious burns to skin tissues. Contact with nickel compounds may cause skin sensitization, resulting in chronic eczema or nickel itch.

Ingestion: Ingestion of electrolyte solution causes tissue damage to throat area and gastro/respiratory tract. Ingestion of cadmium and/or nickel compounds causes nausea and intestinal disorders.

Inhalation: Mists generated during activation procedures may cause varying degrees of irritation to the nasal mucous membranes and respiratory tract tissues varying from mild irritation of nasal mucous membranes to damage of lung tissues proper. Inhalation of cadmium compounds may cause dry throat, cough, headache, vomiting, chest pain, and/or chills. Excessive overexposure may result in pulmonary edema, breathing difficulty, and prostration.

Carcinogenicity: NIOSH recommends that nickel and cadmium be treated as occupational carcinogens.

2. EMERGENCY FIRST AID

Battery Electrolyte (Electrolyte is 18-28% Potassium Hydroxide or KOH)

Eye Contact: Flush with plenty of water for at least 20 minutes. Get immediate medical attention.

Skin Contact: Remove contaminated clothing and flush affected areas with plenty of water for at least 20 minutes.

Ingestion: Do not induce vomiting. Dilute by giving large volumes of water or milk. Get immediate medical attention. Do not give anything by mouth to an unconscious person.

Inhalation: Remove to fresh air. Give oxygen or artificial respiration if needed. Get immediate medical attention.

Nickel and Cadmium Compounds

Skin contact: Wash with cold water and soap for 15 minutes.

3. SPECIAL PROTECTION INFORMATION

Perform activation procedures in a well-ventilated area. Battery operating areas must be well ventilated for removal of potentially dangerous and harmful gases generated. Normal reactions inside the battery liberate explosive and flammable hydrogen gas.

Respiratory Protection: Use NIOSH-approved mist respirator during activation and actual usage to maintain exposure levels below the TWA.

Eye Protection: Use splash goggles or face shield whenever handling a battery.

Hand Protection: If exposure to electrolyte solution or dried salts is likely, use any water-insoluble, non-permeable glove, i.e., synthetic rubber.

DO NOT use leather or wool.

Other protective Equipment: Rubber boots, rubber apron or rainwear, or equivalent if exposure to electrolyte solution is likely.

4. REACTIVITY DATA

CAUTION: NEVER ACTIVATE OR TOP OFF WITH ACID.

Incompatibilities: Aluminum, zinc, tin and other active metals, acid, chlorinated and aromatic hydrocarbons, nitrocarbons, halocarbons.

Trichlorethylene will react with electrolyte solution to form dichloroacetylene which is spontaneously combustible.

Hazardous Decomposition Products: Nickel compounds, cadmium compounds, and potassium hydroxide.

Note that normal reactions inside battery liberate explosive and flammable hydrogen gas. Do not seal battery from atmosphere.

Hazardous Polymerization will not occur.

5. FIRE AND EXPLOSION HAZARDS

<table>
<thead>
<tr>
<th>Case Material</th>
<th>Polypropylene</th>
<th>Acrylic</th>
<th>Polysulfone</th>
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</thead>
<tbody>
<tr>
<td>Melting Point</td>
<td>279°F</td>
<td>210°F</td>
<td>374°F</td>
</tr>
<tr>
<td>Decomposition (non-violent)</td>
<td>550°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auto Ignition</td>
<td>570°F - 580°F</td>
<td>1022°F (550°C)</td>
<td></td>
</tr>
<tr>
<td>Extinguishing Media</td>
<td>CO₂, Sand</td>
<td>CO₂, Sand</td>
<td>CO₂, Sand</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Metal</th>
<th>Melting Point</th>
<th>Boiling Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium</td>
<td>608°F</td>
<td>1410°F</td>
</tr>
<tr>
<td>Cadmium Hydroxide</td>
<td>N/A</td>
<td>2838°F (sublimes)</td>
</tr>
<tr>
<td>Nickel</td>
<td>2645°F</td>
<td>4950°F</td>
</tr>
<tr>
<td>Nickel Hydroxide</td>
<td>N/A</td>
<td>445°F (Decomposes to NiO)</td>
</tr>
</tbody>
</table>
5. FIRE AND EXPLOSION HAZARDS - continued

Special Fire Fighting Procedures: Use self-contained breathing apparatus to avoid breathing toxic fumes. Wear protective clothing and equipment to prevent potential body contact with electrolyte solution or mixture of water and electrolyte solution. **Disconnect or cut all cables to and from battery – especially ground connection.**

Fire and Explosion Hazards: Electrolyte solution is corrosive to all human tissues. It will react violently with many organic chemicals, especially nitrocarbons and chlorocarbons. Electrolyte solution reacts with zinc, aluminum, tin and other active materials releasing flammable hydrogen gas. Cadmium fumes may be released when batteries are subjected to high temperatures. **In case of fire, do not breathe smoke and fumes!**

### 6.0 INGREDIENTS

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS#</th>
<th>EXPOSURE LIMITS</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cadmium (as Cadmium)</td>
<td>7440-43-9</td>
<td>5.0 ug/m³ dust – OSHA</td>
<td>8%</td>
</tr>
<tr>
<td>Cadmium Hydroxide</td>
<td>21041-95-2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel (as Nickel and)</td>
<td>7440-02-0</td>
<td>1 mg/m³ – OSHA</td>
<td>9%</td>
</tr>
<tr>
<td>Nickel Hydroxide</td>
<td>1295-44-87</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cadmium (as Cobalt Hydroxide)</td>
<td>1310-48-4</td>
<td>0.1 mg/m³ dust – OSHA</td>
<td>≈ 0.2%</td>
</tr>
<tr>
<td>Electrolyte Solution (18-28% KOH)</td>
<td>1310-58-3</td>
<td>2 mg/m³ ACGIH CEILING-Air</td>
<td>29%</td>
</tr>
<tr>
<td>Acrylic Polymer Container</td>
<td>None Established – OSHA</td>
<td>≈ 10%</td>
<td></td>
</tr>
<tr>
<td>Polysulfone Container</td>
<td>None Established – OSHA</td>
<td>≈ 10%</td>
<td></td>
</tr>
<tr>
<td>Polypropylene container</td>
<td>None Established – OSHA</td>
<td>≈ 10%</td>
<td></td>
</tr>
<tr>
<td>Lithium Hydroxide</td>
<td>1310-66-3</td>
<td>None Established – OSHA</td>
<td>&lt; 1%</td>
</tr>
<tr>
<td>Graphite</td>
<td>15 mg/m³ use respirator</td>
<td>≈ 3%</td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>None Established – OSHA</td>
<td>≈ 39%</td>
<td></td>
</tr>
</tbody>
</table>

### 7. PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiling Point – Not Applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vapor Pressure – 2 mm Hg at 68°F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specific Gravity – 1.170 - 1.250 (electrolyte)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solubility in Water – Electrolyte solution is completely soluble.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting Point – Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vapor Density – Not applicable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporation Rate – Not Determined</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remainder – is insoluble</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 8. SPILL MANAGEMENT PROCEDURES

**Small electrolyte solution spills (up to 5 gallons):** Flush with water and neutralize with dilute citric acid. **Large spills:** Contain material in suitable containers or holding area. **DO NOT** allow material to enter sewers, streams, or storm conduits. Recover material with vacuum truck and dispose of properly. 


### 9. DISPOSAL INFORMATION

Nickel-cadmium storage batteries are universal wastes under RCRA. They may be returned to SAFT for recycling. These batteries are TCLP Toxic. These batteries and the electrolyte solution they contain are considered to be corrosives. If not recycled, they must be disposed of in accordance with all federal, state, and local hazardous waste regulations.

### 10. PRECAUTIONS AND COMMENTS

These batteries may be highly charged and are capable of high energy discharge. Care should be taken to handle them properly to avoid shorting or misuse that will result in a rapid, uncontrolled electrical, chemical, or heat energy release. Do not transport activated batteries without vent caps in place. When removing battery from service, visually inspect for leakage prior to handling. If leakage has occurred follow Spill Management Procedures. Do not allow an exposed flame or spark to come near the cells.

### 11. EPCRA REPORTING REQUIREMENTS

Section 313 Supplier Notification – This product contains the following EPCRA Section 313 chemicals subject to the reporting requirements of Section 313 if the Emergency Planning and Community Right-To-Know Act of 1986 (40 CFR 372):

<table>
<thead>
<tr>
<th>CAS #</th>
<th>Chemical Name</th>
<th>Percent by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>7440-43-9</td>
<td>Cadmium</td>
<td>8%</td>
</tr>
<tr>
<td>7440-02-0</td>
<td>Nickel</td>
<td>9%</td>
</tr>
<tr>
<td>7440-48-4</td>
<td>Cobalt</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

A copy of this MSDS may be required to be filed with your local emergency planning commission, state emergency response commission, and local fire department in accordance with sections of the Emergency Planning and Community right-To-Know Act.

### 12. TRANSPORTATION INFORMATION

Batteries being forwarded or being returned to Saft for repair should be shipped as Hazardous Material using the following description: Batteries, Wet, Filled with Alkali, 8, UN2795, PG III. 
Spent batteries being sent to Saft for recycling should be shipped as Universal Waste using the following description: Used Batteries, Wet, Filled with Alkali, 8, UN2795, PG III. 

**Disclaimer:** This information has been compiled from sources considered to be dependable and is, to the best of our knowledge and belief, accurate and reliable as of the dated compiled. However, no representation, warranty (either expressed or implied) or guarantee is made to the accuracy, reliability or completeness of the information contained herein. This information relates to the specific material designated and may not be valid for such material used in combination with any other materials or in any process. It is the user’s responsibility to satisfy himself as to the suitability and completeness of this information for his own particular use. We do not accept liability for any loss or damage that may occur, whether direct, indirect, incidental or consequential, from the use of this information nor do we offer warranty against patent infringement. Additional information is available by calling the telephone number above designated for this purpose.
Parts and Accessories
<table>
<thead>
<tr>
<th>Description</th>
<th>Part No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>End Lug Kit for 20mm post (SCM Cells)</td>
<td>66-03379-50</td>
</tr>
<tr>
<td>End Lug Kit for 10mm post (SPL Cells)</td>
<td>66-03379-52</td>
</tr>
<tr>
<td>Terminal, #10-6AWG, crimp type, nickel plated</td>
<td>01-01670-23</td>
</tr>
<tr>
<td>Flip Top Flame Arrestor Vent Cap (orange)</td>
<td>31-04448-02</td>
</tr>
<tr>
<td><strong>for 'ED', SPL, and SCM</strong> cells</td>
<td></td>
</tr>
<tr>
<td>Flip Top Flame Arrestor Vent Cap (red)</td>
<td>31-04447-12</td>
</tr>
<tr>
<td>**for ** SCM 83T and SCM101T ONLY'</td>
<td></td>
</tr>
<tr>
<td>Terminal bolt, 10mm x 16mm SPL</td>
<td>21-21032-27</td>
</tr>
<tr>
<td>Pole Nut (20mm post) SCM</td>
<td>31-03013-01</td>
</tr>
<tr>
<td>Washer, Wave for SPL cells</td>
<td>21-46331-18</td>
</tr>
<tr>
<td>Washer, Wave for SCM cells</td>
<td>21-46011-27</td>
</tr>
<tr>
<td>Wrench, 16mm, Insulated, open end for SPL terminal bolt</td>
<td>01-01832-02</td>
</tr>
<tr>
<td>Wrench, 16mm, Insulated, box end for SPL terminal bolt</td>
<td>01-01898-02</td>
</tr>
<tr>
<td>Wrench, 30mm, insulated, box end for SCM pole nut</td>
<td>80-00008-87</td>
</tr>
<tr>
<td>Socket, 16mm, Insulated, ½” drive, for SPL terminal bolt</td>
<td>16mm – 0.5</td>
</tr>
<tr>
<td>Intercell Connector SPL 80 &amp; 130 (was -39)</td>
<td>31-00429-40</td>
</tr>
<tr>
<td>Intercell Connector SPL 165 &amp; 200</td>
<td>31-00429-28</td>
</tr>
<tr>
<td>Intercell Connector SPL 250 &amp; 380</td>
<td>31-00429-07</td>
</tr>
<tr>
<td>Intercell Connector SPL 340</td>
<td>31-00429-09</td>
</tr>
<tr>
<td>Intercell Connector SPL 290 &amp; 420(4ea-9cell tray)</td>
<td>31-00429-09 &amp; -07</td>
</tr>
<tr>
<td>( 4ea -09 &amp;5ea-07 per 10cell tray)</td>
<td></td>
</tr>
<tr>
<td>Intercell Connector SCM83T</td>
<td>31-03053-01</td>
</tr>
<tr>
<td>Intercell Connector SCM101T</td>
<td>31-03053-02</td>
</tr>
<tr>
<td>Intercell Connector SCM145T, 167T, 211T</td>
<td>31-03053-04</td>
</tr>
<tr>
<td>Intercell Connector SCM254T &amp; 341T</td>
<td>31-03053-03</td>
</tr>
<tr>
<td>Interpole Connector SPL250 (collector bar)</td>
<td>31-00429-05</td>
</tr>
<tr>
<td>Interpole Connector SPL 290</td>
<td>31-00429-06</td>
</tr>
<tr>
<td>Interpole Connector SPL 340</td>
<td>31-00429-07</td>
</tr>
<tr>
<td>Interpole Connector SPL 380</td>
<td>31-00741-11</td>
</tr>
<tr>
<td>Interpole Connector SPL 420</td>
<td>31-00741-10</td>
</tr>
<tr>
<td>Interpole Connector SCM254T</td>
<td>31-03053-06</td>
</tr>
<tr>
<td>Interpole Connector SCM341T</td>
<td>31-03053-07</td>
</tr>
<tr>
<td>Description</td>
<td>Part No.</td>
</tr>
<tr>
<td>-------------------------------------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>Intercell Connector Insulator Cover SPL (500mm)</td>
<td>31-00349-00</td>
</tr>
<tr>
<td>Intercell Connector Insulator Cover SCM (500mm)</td>
<td>31-03056-01</td>
</tr>
<tr>
<td>Hydrometer</td>
<td>01-01980-01</td>
</tr>
<tr>
<td>Thermometer</td>
<td>80-59068-01</td>
</tr>
<tr>
<td>Filler Bulb (#79-84071)</td>
<td>80-51081-01</td>
</tr>
<tr>
<td>Solution Level Indicator</td>
<td>80-59033-01</td>
</tr>
<tr>
<td>Electrolyte Test Kit</td>
<td>03-52378-01</td>
</tr>
<tr>
<td>Filler Bottle, 2L</td>
<td>08-00175-01</td>
</tr>
<tr>
<td>PS300 De-Ionizer, complete, wall mount</td>
<td>80-13602-01</td>
</tr>
<tr>
<td>PS300 De-Ionizer cartridge, replacement</td>
<td>80-03599-01</td>
</tr>
<tr>
<td>Cell Oil – 1 ltr</td>
<td>11-71001-02</td>
</tr>
<tr>
<td>- 5 ltr</td>
<td>11-71001-03</td>
</tr>
<tr>
<td>Nox-Rust - 2 oz.</td>
<td>80-02986-01</td>
</tr>
<tr>
<td>- 8 oz.</td>
<td>80-02986-02</td>
</tr>
<tr>
<td>Refill Liquid Electrolyte (E13/1.21)</td>
<td></td>
</tr>
<tr>
<td>1 gallon (10 lb.) Plastic Bottle</td>
<td>80-59401-01</td>
</tr>
<tr>
<td>5 gallon (50 lb.) Plastic Drum</td>
<td>80-59401-02</td>
</tr>
<tr>
<td>15 gallon (150 lb.) Plastic Drum</td>
<td>80-59401-15</td>
</tr>
<tr>
<td>55 gallon (550 lb.)</td>
<td>80-59401-05</td>
</tr>
<tr>
<td>Refill Liquid Electrolyte (E12/1.25)</td>
<td></td>
</tr>
<tr>
<td>(specific gravity 1.25)</td>
<td></td>
</tr>
<tr>
<td>1 gallon (10 lb.) Plastic Bottle</td>
<td>80-59179-01</td>
</tr>
<tr>
<td>5 gallon (50 lb.) Plastic Drum</td>
<td>80-59179-05</td>
</tr>
<tr>
<td>15 gallon (150 lb.) Plastic Drum</td>
<td>80-59179-15</td>
</tr>
</tbody>
</table>
Recommended Voltages for Saft SPL NiCd.
Voltages set at $20^\circ/68-70^\circ F$

Maximum float voltage 1.45 VPC
- 9-cell bank - 13.05 max
- 10-cell bank - 14.50 max
- 11-cell bank - 15.95 max

Recommended min. commissioning voltage 1.60 VPC
Constant voltage charger for 24 – 48 hrs
Note equipment voltage range, prior to commissioning charge
- 9-cell bank – 14.40 max
- 10-cell bank – 16.00 max
- 11-cell bank – 17.60 max

Notes:
1. Do not top up cell prior to initial charge.
   Electrolyte level should be $\frac{1}{2} - \frac{3}{4} "$ below max. level
2. Disconnect / turn off temp compensation to set voltages
3. Set voltages at battery terminals.